Society of Arts.

REPORT OF THE COMMITTEE

ON

LEATHER FOR BOOKBINDING.

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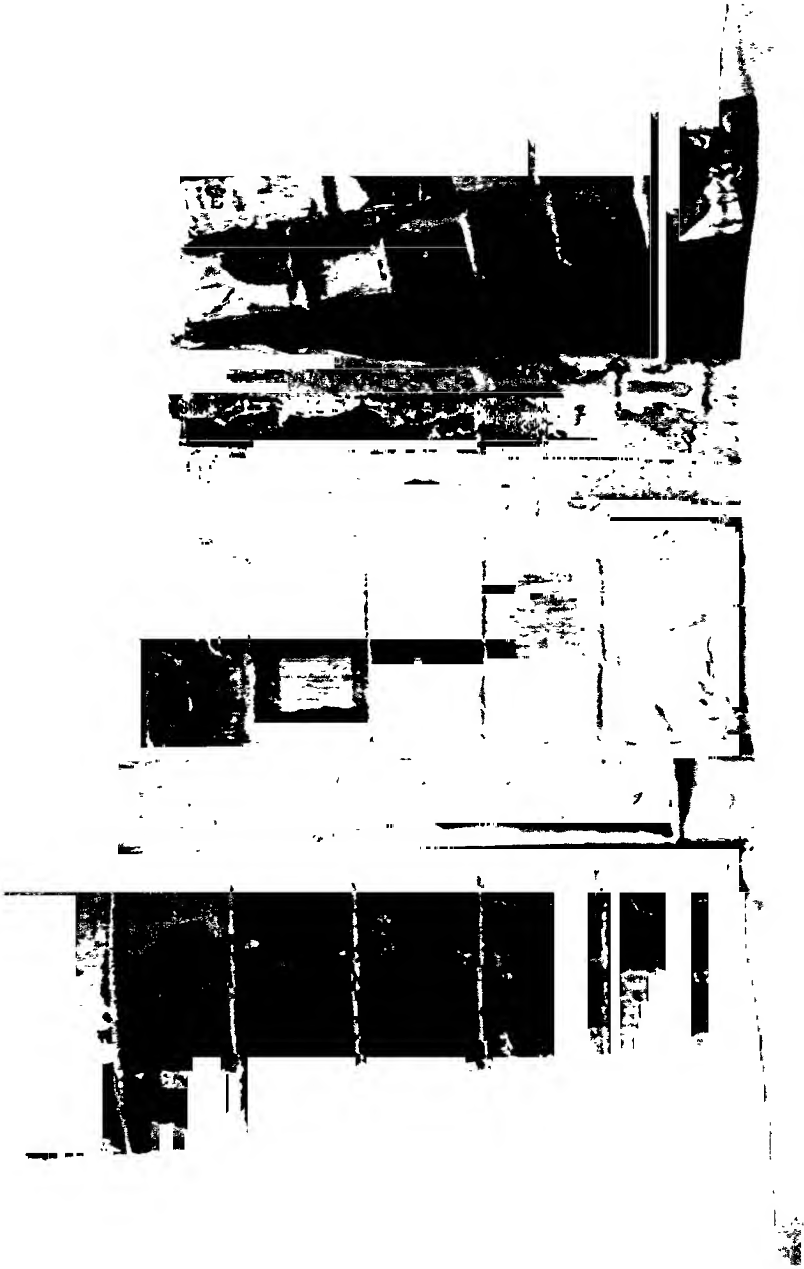

REPORT OF THE COMMITTEE

ON

LEATHER FOR BOOKBINDING.

EDITED FOR

THE SOCIETY OF ARTS

AND

THE WORSHIPFUL COMPANY OF LEATHERSELLERS

BY

THE RT. HON. VISCOUNT COBHAM

CHAIRMAN OF THE COMMITTEE

AND

SIR HENRY TRUEMAN WOOD, M.A.

SECRETARY OF THE SOCIETY

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REPORT OF THE COMMITTEE

ON

LEATHER FOR BOOKBINDING.

PART I.—INTRODUCTORY.

THE decay of leather used for bookbindings has for long been a subject which has attracted a great deal of attention and interest amongst librarians and book collectors. The first attempt to investigate the conditions leading to such decay appears to have been made by Faraday, whose historic researches into the condition of the library of the Athenæum Club in 1842 still remain the only serious attempt made to investigate this subject.* Of late years the matter has received still more earnest attention, owing to a growing belief

* Professor Faraday delivered a lecture on "Light and Ventilation," at the Royal Institution, on the 7th of April, 1843, which was chiefly devoted to the consideration of the ventilation of lighthouses; in the latter part of the lecture, however, allusion was made to the ventilation of the Athenæum Club. His "new mode of ventilating burners of lamps" is thus described. It "consists in using two glass chimneys, one within the other, the outer one being covered by a sheet of mica, and the products of combustion pass up the interior glass chimney, and then pass down inside the outer glass chimney, the products of combustion being then received into a pipe which carries them into the outer atmosphere." Mr. James Faraday read a paper before the Institution of Civil Engineers on the 13th of June, 1843, entitled: "Description of a mode of obtaining the perfect ventilation of Lamp-Burners" (Proceedings of the Institution, vol. ii. p. 184). Professor Michael Faraday spoke in the discussion that followed the paper.

among librarians that the quality of the leathers now made for bookbinding purposes is inferior to that made previous to, say, the middle of the last century. The matter has been discussed on several occasions at meetings of the Library Association, and in the year 1899 a meeting of persons specially interested in the question was held at the Central School of Arts and Crafts in Regent Street, under the chairmanship of Mr. Cobden-Sanderson. This meeting formed itself into a Committee to encourage the production of sound and durable leather for bookbinding. The Committee held several meetings, and some of its members carried out a good deal of investigation and experiment, but it appears to have come to the conclusion that the matter was too large a one to be dealt with by a separate and informal body of the sort, and it was decided to request the Council of the Society of Arts to undertake a thorough investigation of the whole question, and, after having done so, to issue a Report upon it.

In February 1900, the Council of the Society of Arts acceded to this request, and appointed a Committee, with instructions to enquire fully into the subject, and to report on the durability of the leathers now used for the purpose of binding books. This Committee met for the first time on the 3rd of May, 1900, when Lord Cobham was elected as Chairman. Its first step was to appoint two Sub-Committees from amongst its members. The duty of the first of these was to visit a selected number of libraries and to ascertain the comparative durability of the various bookbinding leathers used at different periods and preserved under different

conditions. This Sub-Committee was composed of the following members: Mr. Cyril Davenport, Dr. J. Gordon Parker, Mr. A. Seymour-Jones, Mr. W. J. Leighton, and Mr. Douglas Cockerell. The second Sub-Committee—consisting of Dr. J. Gordon Parker, Professor Henry R. Procter, and Mr. A. Seymour-Jones—was appointed to deal with the scientific side of the matter, to ascertain the cause of any deterioration noticed, and, if possible, to suggest methods for its prevention in the future.

The Committee presented its Report to the Council of the Society of Arts on the 17th of June, 1901, and the Report was printed in the Journal of the Society for the 5th of July of that year. As it was the opinion of the members of the Scientific Sub-Committee that a good deal of work yet remained to be done, the Committee was re-appointed by the Council, with the idea that if they found it necessary they might issue a further Report.

At one of the first meetings of the Committee, after its re-appointment, a suggestion was made that it would be desirable that the Report should appear in a more permanent form than that of its original publication, and that it should contain coloured illustrations showing the actual effect of light and other injurious agents on leather. The cost of a publication such as was proposed being somewhat in excess of the amount which could be devoted to the purpose by the Society of Arts, an application was made to the Court of the Leathersellers' Company asking whether they would assist the Society, and the Court, after carefully considering the application, very liberally undertook to provide a sum not exceeding £250 towards the expense of the

republication of the Report in an extended form and with illustrations.

The Committee desire to express their warm appreciation of this liberal action on the part of the Court of the Leathersellers' Company, without which it would have been impossible to produce in its present form a work which they trust may be of some permanent value.

The Report as originally published consisted of a summarised statement of the results arrived at by the two Sub-Committees, each of which had presented a Report to the General Committee. These Reports were published in the form of Appendices, it being considered better to treat them in this manner than to attempt an amalgamation of the two into a single Report. In addition there was a short Appendix containing "Hints to Owners and Keepers of Libraries," by the Chairman of the Committee (Lord Cobham), and a fourth Appendix in which were reprinted the circular issued to Librarians and the replies obtained from them.

In the present re-issue of the Report, it has been thought best somewhat to modify this arrangement. The two reports of the Sub-Committees, embodying as they do the whole of the Committee's work, are treated as integral parts of the Report, and are now printed as Parts II. and III., the summary of their work originally published as the Report of the Committee, now forming Part I. As a fresh Appendix, there has been added a valuable paper by Mr. M. C. Lamb,* on "Leather Dyes and Dyeing," which gives the results of an elaborate series of experiments made by him on the per-

* Mr. Lamb was added to the Committee in December 1902.

manency of dyes on leather, and the effect of light upon dyes. Part II., formerly Appendix II.—the Report of the Scientific Sub-Committee—has been practically re-written, and has been made to include many details of the experiments carried out for the purpose of this enquiry, the results only of which were given in the Report as originally printed.

The illustrations are all new. They comprise eleven coloured plates, a reproduction of some photomicrographs, and a number of illustrations in the text.

Plate I. (Frontispiece) shows specimens of books bound within the last fifty years. The first three are in morocco, and show the red decay mentioned on page 38. The last three are in calf, showing how the material powders away. It will be noticed that the sewing and the bands of all the examples are quite sound.

Plates II. to IX. (at end of book) give illustrations (in colour), showing the effects of light and of various injurious agents (gas, moisture, etc.) on various tanned leathers.

Plates X. and XI. (at end of book) illustrate the fading of various dyed leathers (Appendix II., page 77).

The other illustrations include diagrams of the breaking stresses of certain samples of leather, photomicrographs of grain of various skins, and a number of sketches intended to illustrate the method of binding recommended by the Committee. These will all be found in the parts of the Report to which they refer.

The Report of the first Sub-Committee will

be found on page 17, and forms Part II. of this Report. The first step taken by the Sub-Committee was to visit a number of libraries, including that of the British Museum; the Bodleian Library, Oxford; the University Library, Cambridge; the libraries of the Athenæum Club, of the Patent Office, and of the Chemical Society; also the valuable private library of Mr. Huth. The objects they set before themselves in their investigation were to ascertain if the complaints of the premature decay of modern bookbinding leathers are justified by facts, and, if so, to ascertain at about what date leather began noticeably to deteriorate; to find out, by noticing the conditions under which the books were kept, the effect of environment on the durability of the leather; to decide on the relative suitability of various leathers for bookbinding; to suggest practicable methods by which the quality of the leather could be improved; and to decide on the best conditions under which books can be kept. Part of this work was afterwards delegated to the second Sub-Committee, and indeed it was not always possible to keep entirely distinct the work of the two Sub-Committees. On some points they worked together. Some slight over-lapping may be found in the two Reports, but on the whole it will be found that the original division of labour has been fairly well preserved.

As regards the common belief that modern binding leather does decay prematurely, the Sub-Committee satisfied themselves that books bound during the last eighty or hundred years showed far greater evidence of deterioration than those of an earlier date. Many recent bindings showed evi-

dence of decay after so short a period as ten, or even five years. The Sub-Committee came to the conclusion that there is ample justification for the general complaint that modern leather is not so durable as that formerly used. To fix the date of the commencement of this deterioration was a difficult matter; but they came to the conclusion that while leather of all periods showed some signs of decay, the deterioration becomes more general in books bound after 1830, while some leathers seem to be generally good until about 1860, after which date nearly all leathers seem to get worse. The deterioration of calf bindings at the latter end of the nineteenth century may be attributed as much to the excessive thinness as to the poor quality of the material.

With regard to the conditions under which books are kept, ventilation, lighting, heating, etc., the Committee were satisfied that in libraries in which no artificial light was used, and where the ventilation was good, the bindings were generally in a better state than elsewhere. Where gas was used the bindings were in the worst state noticed, especially on the higher shelves. Books kept in much used rooms were generally in a bad state—though whether it was really due to gas or other fumes could not be decided. Tobacco smoke was certainly injurious. Daylight, and still more direct sunlight, had a disintegrating effect on leather. Books kept in cases with closely fitting doors, were generally in a better condition than those exposed directly to the atmosphere. Where, however, owing to the dampness of the walls, or other causes, moisture obtained admission to such cases, the

books then suffered more than if they were in a well-ventilated place.

As to the suitability of various leathers, the Sub-Committee came to the conclusion that of the old leathers (15th and 16th century), white pigskin, probably alum tanned, is the most durable, but its excessive hardness and want of flexibility renders this leather unsuitable for most modern work. Old brown calf has lasted fairly well, but loses its flexibility, and becomes stiff and brittle when exposed to light and air. Some of the white tawed skins of the 15th and 16th century, other than white pigskin, and probably deerskin, have lasted very well. Some 15th and 16th century sheepskin bindings have remained soft and flexible, but the surface is soft and usually much damaged by friction. Vellum seems to have lasted fairly well, but is easily influenced by atmospheric changes, and is much affected by light. Early specimens of red morocco from the 16th to the end of the 18th century were found in good condition, and of all the leathers noticed, this seems to be the least affected by the various conditions to which it had been subjected. In the opinion of the Sub-Committee, most of this leather has been tanned with sumach or some closely allied tanning material. Morocco bindings earlier than 1860 were generally found to be in fairly good condition, but morocco after that date seems to be much less reliable, and in many cases has become utterly rotten. During the latter part of the 18th century it became customary to pare down calf until it was as thin as paper. Since about 1830 hardly any really sound calf seems to have been used, as, whether thick or thin, it appears generally to have perished. Sheep-

skin bindings of the early part of the century are many of them still in good condition. Since about 1860 sheepskin as sheepskin is hardly to be found. Sheepskins are grained in imitation of other leathers, and these imitation-grained leathers are generally found to be in a worse condition than any of the other bindings, except, perhaps, some of the very thin calfskin. Undyed modern pigskin seems to last well, but some coloured pigskin bindings have entirely perished. Modern leathers dyed with the aid of sulphuric acid are all to be condemned. In nearly every case Russia leather was found to have become rotten, at least in bindings of the last fifty years.

On the whole, the Sub-Committee came to the conclusion that a pure sumach tannage will provide a good and durable leather, and that leather may be produced which will prove as durable as any made in the past. The Sub-Committee also came to the conclusion that the bookbinder must share with the leather manufacturer and librarian the blame for much of the premature decay of leather bindings. The objections which the Sub-Committee take to modern bindings are set out in their Report, where will also be found two suggested specifications, one for binding heavy or valuable books, and one for ordinary library binding.

At the suggestion of the Sub-Committee a circular was sent to 119 librarians throughout the country, asking for information as to the effect of bookbindings showing deterioration, and the conditions under which books were kept in the different libraries, also for the opinions of the librarian as to the class of leather he considered the best for book-

binding. A copy of the circular letter issued, a list of the libraries sending answers, and a tabular statement embodying the information received, will be found in Appendix III. (page 88).

The second Sub-Committee was composed of chemists specially conversant with the treatment of leather. Their Report forms Part III., and commences on page 37. The work of this Sub-Committee was directed specially to the elucidation of the following points: an investigation of the nature of the decay of leather used for bookbinding; an examination of the causes which produced this decay; a research into the best methods of preparing leather for bookbinding; and a consideration of the points required to be dealt with in the preservation of books.

Taking these points in order, the first one dealt with is the question of the nature of the decay of leather. To arrive at their conclusions on this subject, the Sub-Committee made a number of tests and analyses of samples of decayed leather bookbindings, as well as of leathers used for binding. The Committee found that the most prevalent decay was what they term a red decay, and this they think may be differentiated into old and new, the old red decay being noticeable up to about 1830, and the new decay since that date. In the old decay, the leather becomes hard and brittle, the surface not being easily abraded by friction. The older form is specially noticeable in calf-bound books, tanned presumably with oak bark. The new form affects nearly all leathers, and in extreme cases, seems absolutely to destroy the fibres. Another form of deterioration, more noticeable in the newer books,

renders the grain of the leather liable to peel off when exposed to the slightest friction. This is the most common form of decay noted in the most recent leathers. In nearly all samples of Russia leather a very violent form of red decay was noticed. In many cases the leather was found to be absolutely rotten in all parts exposed to light and air, so that on the very slightest rubbing with a blunt instrument the leather fell into fine dust. It appears to be a general opinion that leather, and especially Russia leather, lasts better on books that are in constant use. This is attributed to the slight amount of grease absorbed by the leather from the hand, and it has been suggested that possibly a suitable dressing may be discovered which would have a similar effect on the leather as is produced by this grease.

The second point is the cause of the decay. An extensive series of experiments was carried out with a view of determining the causes of the decay of bindings. The Sub-Committee found that this was caused both by mechanical and by chemical influences. Of the latter some are due to mistakes of the leather manufacturer and the bookbinder, others to the want of ventilation, and to improper heating and lighting of libraries. In some cases inferior leathers are finished (by methods in themselves injurious) so as to imitate the better class leathers, and of course, where these are used durability cannot be expected. But in the main the injury for which the manufacturer and bookbinder are responsible must be attributed rather to ignorance of the effect of the means employed to give the leather the outward qualities required for

binding than to the intentional production of an inferior article. Full details of the experiments made, and the conclusions at which the Sub-Committee arrived will be found in the report of the Sub-Committee, and considerable additions have been made to the original report. Great stress is laid on the injurious effects of sulphuric acid, which appears to be universally employed as a "brightening" agent or in the dye-bath. The Sub-Committee are strongly opposed to its use, and hope that some substitute, such as formic acid, may be found. When sulphuric acid is employed special means are recommended for its neutralisation. In addition to the injury to leather often caused by the treatment in the earlier stages of preparation, leathers produced by different tanning materials, although they may be equally sound and durable mechanically, vary very much in their resistance to other influences, such as light, heat, and gas fumes.

For bookbinding purposes, the Sub-Committee generally condemn the use of tanning materials belonging to the catechol group, although the leathers produced by the use of these materials are for many purposes excellent and indeed superior. The class of tanning materials which produce the most suitable leather for this particular purpose belong to the pyrogallol group, of which a well-known and important example is sumach. East Indian or "Persian" tanned sheep and goat skins, which are suitable for many purposes, and are now used largely for cheap bookbinding purposes, are considered extremely bad. Books bound in these materials have been found to show signs of decay

in less than twelve months, and the Sub-Committee are inclined to believe that no book bound in these leathers, exposed on a shelf to sunlight or gas fumes, can ever be expected to last more than five or six years. Embossing leather under heavy pressure to imitate a grain has a very injurious effect, while the shaving of thick skins greatly reduces the strength of the leather by cutting away the tough fibres of the inner part of the skin. The use of mineral acids in brightening the colour of leather, and in the process of dyeing, has a serious effect in lessening its resistance to decay. A good deal yet remains to be learned about the relative permanency of the different dyes.

Next to the causes of decay due to the original treatment of the leather, come the conditions to which the book is exposed in the library. To try these a very careful series of tests was made. Leathers were exposed under various conditions to gas fumes, to light (sunlight, gaslight, and electric light), and to heat. As the result of these experiments, the Sub-Committee consider that of the deleterious influences to which books are subjected, the fumes of burnt gas are the most fatal. The results of the experiments of exposing leathers to light of various colours was somewhat unexpected. It was found that leathers of a different character act in very different ways—some are bleached or darkened very rapidly by the action of direct sunlight, others resist for a longer period. Most leathers, however, appear to be affected, not only in colour, but in their actual substance. As regards sunlight, experiments were made by exposing the leathers under differently coloured glasses, and a

simple test is proposed for the character of the light most suitable for libraries, as it is found that the action of light upon leather is quite comparable with the action of light upon ordinary photographic printing paper. Glass which is to be used for glazing library windows can therefore be tested by trying its action on such a material as ordinary photographic paper, and it is suggested that all library windows which are exposed to the direct rays of the sun ought to be glazed with glass of a slight yellow or olive tint, so as to exclude as much as possible the more chemically active rays. It was also found that a darkening action was produced by exposure to artificial light, though it is not quite certain that the effects observed were not partially due to the radiant heat. So far as the Sub-Committee were able to ascertain, these effects were not so much due to the effect of oxidation as to the action of light, warmth, and moisture. The effect of ammonia fumes was very marked, and tobacco smoke was also found to have a similar darkening and deleterious effect, so much so that the Sub-Committee have no doubt that the deterioration of bindings in a library where smoking is carried on is partly due to this cause.

On the whole, the Sub-Committee are satisfied that of all the influences to which books are exposed in libraries, gas fumes—no doubt because of the sulphuric and sulphurous acid which they contain—are shown to be the most injurious, but light, and especially direct sunlight and hot air, are shown to possess deleterious influences which had scarcely been suspected previously, and the importance of moderate temperature and

thorough ventilation of libraries cannot be too much insisted on.

The conclusions at which the Committee have arrived, may be summarised as follows:—

1. They consider that the general belief that modern bookbinding leather is inferior to that formerly used, is justified, and that the leather now used for binding books is less durable than that employed fifty years ago, and at previous times. They believe that there ought to be no difficulty in providing leather at the present time as good as any previously made, and they hope that the instructions laid down in the Report of the Sub-Committee, will result in the production of such leather.

2. They think that the modern methods of bookbinding are, to some extent, answerable for the lessened permanence of modern bindings. The practice of shaving down thick skins is a fruitful source of deterioration. They think that the adoption of the method of binding recommended in the Report of the Sub-Committee ought to result in a greater permanence of the books treated.

3. They consider that the conditions under which books are best preserved, are now fairly well understood, except that the injurious effect of light on leather has not previously been appreciated. They are satisfied that gas fumes are the most injurious of all the influences to which books are subjected. They consider that, with proper conditions of ventilation, temperature, and dryness, books may be preserved without deterioration for very long periods, on open shelves, but that there is no doubt that, as a general rule, tightly fitting glass cases conduce to their preservation.

4. The Committee have satisfied themselves that it is possible to test any leather in such a way as to guarantee its suitability for bookbinding. They have not been able to satisfy themselves that it would be either possible or desirable to establish any formal or official standard.

PART II.—REPORT OF SUB-COMMITTEE No. I.

CYRIL DAVENPORT. DR. J. GORDON PARKER.
A. SEYMOUR-JONES. W. J. LEIGHTON.
DOUGLAS COCKERELL.

THIS Sub-Committee was appointed to visit libraries, and to ascertain the comparative durability of the various bookbinding leathers used at different periods and preserved under different conditions.

THE LIBRARIES VISITED, AND THE REASONS FOR SELECTION.

MR. HUTH'S LIBRARY.—A private library of valuable books expensively bound and very well kept. Books under clear glass not against the wall; hot air, even temperature, good ventilation, translucent or tinted glass.

CHEMICAL SOCIETY.—A library largely consisting of sets of transactions and periodicals bound as each year was completed, so that the approximate date of most of the binding could be ascertained. The binding in this library is typical of that in most society and club libraries.

ATHENÆUM CLUB.—Open fires in some rooms; gas until 1890, electric light since. A library distributed through rooms that are a great deal used for the purposes of the club, smoking being permitted in some. The binding is generally of a more expensive kind than at the Chemical Society. It was in this library that Faraday conducted his experiments on the injurious effect on leather bindings of the fumes of burnt gas.

BRITISH MUSEUM.—Library without gas, where bindings of various dates could be compared.

PATENT OFFICE.—A very much used library, in which gas has been used until lately, and where the condition of the binding had been reported to be very bad.

OXFORD AND CAMBRIDGE.—Libraries in comparatively pure air, where no gas has been used, and where there are large numbers of books that have occupied the same places in the shelves for very long periods.

In addition to these, other libraries were visited by various single members of the Sub-Committee.

The aim of the Sub-Committee was—

I. To ascertain if the complaints of the premature decay of modern bookbinding leathers are justified by facts.

And if so—

II. By comparing bindings of different times, to ascertain at about what date the leather began noticeably to deteriorate in quality.

III. By noting the conditions of ventilation, lighting (natural and artificial), heating, etc., in different libraries, and comparing the states of bindings in them, to ascertain the effect of environment on the durability of the leather.

IV. By noting the state of various books bound in various leathers at about the same time and kept under similar conditions, to ascertain the relative suitability of the various leathers for bookbinding.

V. To ascertain how far faulty construction is responsible for the want of durability of modern leather bindings.

In addition to these, the following points were dealt with in collaboration with Sub-Committee No. II. The results of their enquiries are embodied in the Report of that Sub-Committee.

VI. To ascertain the nature and special causes of the various kinds of deterioration noticed.

VII. To suggest practicable methods by which the quality of the leather can be improved, the stability of the binding insured, and the dangerous effects of light, heat, and other external influences in libraries minimised.

The opinions formed by the Sub-Committee on these points, and the reasons for forming them, are given in order.

I.—*If the complaints of the Premature Decay of modern Binding Leather are justified by facts.*

In every library visited the Committee found evidence of decay in bindings of all periods represented, but the books bound during the last 80 to 100 years showed far greater evidence of deterioration than those of an earlier date. Very many recent bindings examined showed evidence of the decay of the leather after as short a period as five years.

On these grounds the Sub-Committee are of opinion that there is ample justification for the very general complaint—that modern bookbinding leather is not as durable as that formerly used.

II.—*By comparing Bindings of Different Times, to ascertain at about what date the Leather began noticeably to deteriorate in quality.*

The Sub-Committee had considerable difficulty in fixing the date of the beginning of the deterioration of modern bookbinding leather. While leather of all periods shows some signs of decay, the deterioration becomes more general on books bound after 1830.

The calf bindings of the fifty years previous to this date show marked deterioration, but this seems to be as much due to the excessive thinness as to the poor quality of the leather. Some leathers seem to be generally good until about 1860, and after that date nearly all leathers seem to get worse.

III.—*By noting the conditions of Ventilation, Lighting (natural and artificial), Heating, etc., in different Libraries, and comparing the state of*

Bindings in them, to ascertain the effect of environment on the durability of the leather.

1. It was noted by the Sub-Committee that, in libraries in which there was no artificial light used, and where ventilation was good, the bindings were generally in a better state than elsewhere. (In some country libraries carefully kept the binding showed very little decay.)

2. That in libraries where gas is, or has been used, the bindings are in the worst state noticed, especially on the higher shelves.

3. That books kept in much used rooms are in a bad state. (Tobacco smoke is injurious.)

4. That ordinary daylight has a disintegrating effect on *certain* leathers. Direct sunlight acts more rapidly, and, according to the almost unanimous opinion of the Sub-Committee, affects all leathers injuriously. In the opinion of one member of the Sub-Committee this is not always the case. He states that he has many examples of the colours being bleached without the leathers suffering, and suggests as the cause of decay the variations of temperature brought about by the direct action of the sun.

5. That in cases where books have been allowed to become and remain in a very dusty condition, the leather has perished.

6. That books kept on book-shelves with glass or other closely fitting doors are generally in a far better condition than those exposed directly to the atmosphere. On the other hand, where exceptional conditions prevail, such as damp on the one hand or excessive dryness on the other, the absence of ventilation in well-made, close-fitting cases, may be a positive evil.

IV.—*By noting the state of various books bound in different Leathers at about the same time and kept under similar conditions, to ascertain the relative suitability of the various Leathers for Bookbinding.*

Of the old leathers (15th and 16th centuries) white pigskin, probably alum tanned, has proved to be by far the most durable, but its excessive hardness and want of flexibility renders this leather, as prepared at that time, unfit for most modern work.

Old brown calf seems to have lasted fairly well, but shows a tendency to lose its flexibility and become very stiff and brittle where exposed to light and air.

Old calf books (1475–1530) with wooden boards seem to have lasted better than others with boards of paper or mill-board, which perhaps more easily absorb damp.

Some of the white tawed skins of the 15th and 16th centuries, other than the white pigskin, and probably deerskin, have lasted very well.

Some coltskin noticed, of the 15th century, was still in very good condition.

Some 15th and 16th century sheepskin bindings have remained quite soft and flexible, but the surface is usually much damaged by friction.

Vellum seems to have lasted fairly well where not exposed for long periods to light, but it is so easily influenced by atmospheric changes as to make it rather an unsatisfactory binding material. It was noticed that where vellum binding had remained on shelves for long periods the side nearest the light had in some cases become as brittle as

egg-shell. The side away from the light remained sound.

From the 16th to towards the end of the 18th century specimens of red morocco were found to be in good condition. Of all the leather noticed, this seemed to be least changed by the various conditions to which it had been subjected. It retained its flexibility and colour to a remarkable extent, keeping a hard surface that was not easily damaged by friction. In the opinion of the Sub-Committee, most of this leather was tanned with sumach or some closely allied tanning material.

At the end of the 18th century and the beginning of the 19th, a red and straight-grained morocco came into general use. This is probably sumach tanned and dyed with cochineal. This leather has lasted remarkably well, as has also, though apparently not so much used, a green straight-grained morocco of the same nature.

During the latter part of the 18th century it became customary to pare down calf for bookbinding purposes until it was as thin as paper. This, as might have been expected, has broken at the joints in nearly every case. After about 1830 and until the present time, hardly any really sound calf seems to have been used, as, whether thick or thin, it has nearly all perished, turning red and crumbling to dust. Sprinkled or marbled calf books are in a specially bad state.

The morocco bindings seem to have been fairly good until about 1860, but after that date very many have become utterly rotten, showing signs of red decay, or of the grain peeling off at the slightest friction.

Sheepskin bindings of the early part of the century are many of them still in good condition. Sheepskin, in a fairly natural state, seems to keep its flexibility, but it is very easily damaged by friction. Since about 1860 sheepskin as sheepskin is hardly to be found. We have instead sheepskins grained in imitation of various other leathers, and these imitation grained leathers are, generally speaking, in a worse condition than any seen by the Sub-Committee, excepting perhaps some of the very thin calf-bindings.

Modern pigskin, if genuine, seems to have lasted very well when in an undyed condition; but some coloured pigskin bindings were found to have utterly perished. Pigskin is naturally a hard, rather stiff leather, and is suitable for large books rather than small. If submitted to severe softening processes in manufacture its durability is very small.

Quite modern leather dyed black seems, in nearly all cases, to have perished, although old black morocco (16th, 17th, and 18th centuries) in good condition is not uncommon.

Russia leather in nearly every case was found to have become utterly rotten. It was stated that if Russia books were very much handled the leather lasted well enough, but when left undisturbed on the shelves it rapidly crumbled to dust. Some Russia leather of the time of the early 19th century on large books, *i.e.* when not pared down too much, has lasted perfectly, but it appears to be a different material from that used now, with a well-defined grain.

It is the opinion of the Sub-Committee, that the ideal bookbinding leather must have and retain

great flexibility. It was noticed generally that in the case of the old bindings the joints had broken on account of the leather becoming stiff and hard, or on account of the bad working of the end papers and the heavy leverage of the boards. Bookbinding leather must have a firm grain surface, not easily damaged by friction. It was noticed that soft and spongy leathers became very shabby. A bookbinding leather should not be artificially grained. It was noticed that in cases of the old leathers that had lasted best no attempt had been made to remove the tan-pit marks, and that modern leathers, with embossed or plated grain, were generally in a very bad condition.

The Sub-Committee are of opinion that a pure sumach tannage will answer all these conditions, and that leather can and will now be produced that will prove to be as durable as any made in the past. A mild oak bark tannage is also satisfactory.

It was noticed that leather bindings that had been coated with glair or varnish were in a better state than those without.

Librarians stated that leather bindings that are much used last better than those that are left undisturbed on the shelves.

VI.—*To ascertain how far Faulty Construction is responsible for the want of Durability of Modern Leather Bindings.*

The investigations of the Sub-Committee served to show that the bookbinder must share, in no small measure, with the leather manufacturer and librarian the blame for the premature decay of leather bindings.

It was noticed that—

1. Books are often sewn on too few cords. That the sewing cord used is usually either too thin in itself, or is rendered so in the joints by the undue thinning of the slips. That binders often cut off some of the slips instead of lacing them into the boards.

These defects render the attachment of the boards to the book almost entirely dependent on the strength of the leather.

In some recently bound folios that the Sub-Committee was permitted to strip, it was found that only three thin cords had been used, and of these

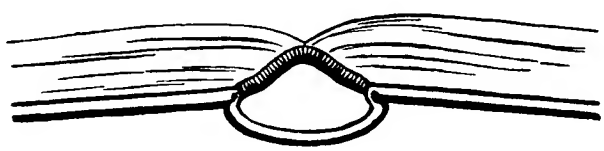


Fig. 1.—Hollow Back.

only two were laced into the boards. In numerous other cases where boards had become detached from books, a similar cause of weakness was detected.

It was observed that the joints of books sewn on tapes that had been properly laced in, or otherwise firmly attached to the boards, had seldom broken.

2. The use of "hollow backs," made as is usual for library work, tends to throw too great a strain on the leather in the joints, and renders the back liable to break away.

In nearly every library visited many books were seen of which the hollow backs were wholly or nearly detached.

Great attention was paid to this point, and it was found by careful examination that the stiff paper linings usual in hollow backs, by preventing the leather on the back from bending freely, exercised a very considerable outward thrust on the leather of the joints as the book was opened. (Fig. 1.)

Fig. 2.—End View of a Flexible Back.

Utilising to the full the special qualities of the leather, enabling the back to throw up and the leaves to open flat.

While recognising that in exceptional cases hollow backs may be used with advantage, the Sub-Committee think that, if used, they should be made with greater care than is possible in most library work. The Sub-Committee consider that for nearly all library books the leather should be attached

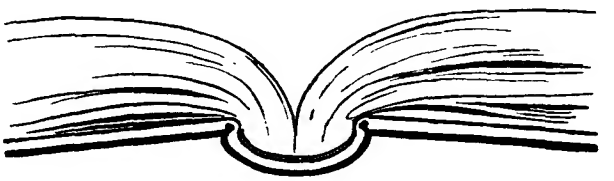


Fig. 3.—Back Lined Up Stiffly.

Preventing the book from opening freely.

directly to the back, as by this means the strength of the leather is used to the best advantage. (Fig. 2.)

3. The leather at the back is apt to become torn through the habit of pulling books from the shelves by the headcaps.

The Sub-Committee were told that in spite of

rules to the contrary, most people pull books forward on the shelves by placing a finger on the headcaps, and many bindings were seen that had been torn by this habit.

The Sub-Committee are of opinion that this method of pulling books from the shelves puts an undue strain on the bindings, especially when books are too tightly packed on the shelf. The headbands and headcaps, however, can be made strong enough, as experience shows, to resist any reasonable strain of this sort, and this should always be done. At present the headbands are often mere shams.

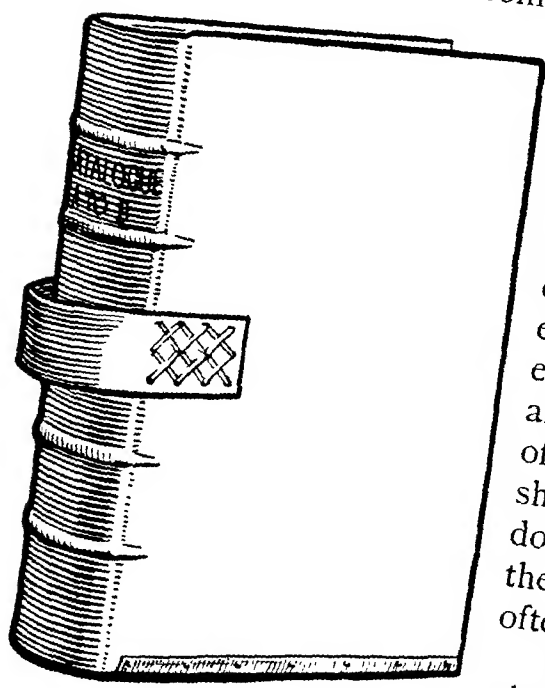


Fig. 4.—Showing STRAP for Pulling Heavy Books from the shelf, and also METAL SHOE at the bottom of the boards to protect the leather.

In some libraries visited it was noticed that straps had been provided to serve as handles, by which the books could be readily removed from the shelves. Some such method is advocated for catalogues, encyclopædias, and other heavy books that are much used. (See Fig. 4.)

4. The leather used is usually too thin, especially for heavy books.

Small naturally thin skins should be used for

small books, so that the natural layers of the skin may remain in some reasonable proportion to one another. Where naturally thick skins very much pared down are used, there is little left but the comparatively brittle and fibreless grain surface.

It was noticed that the leather of many bindings, that had broken in the joints, was as thin as paper, and the Sub-Committee are of opinion that no leather can under any circumstances be expected to last for many years unless it is left reasonably thick.

There is evidently among binders a desire to avoid the soft rounded edges proper to a leather covered article, and to endeavour by reducing the thickness of the skin to obtain hard exact edges like those of a newly planed board.

5. The leather is often made very wet, and stretched a great deal in covering, with the result that on drying it is further strained by contraction, almost to breaking point; leaving a very small margin of strength to meet the accidents of use.

The fibres of leather from the backs of some bindings that had broken in the joint, when examined under a microscope, were found to be dragged apart, and not lying in their natural position.

In order to put their recommendations into a practical form, the Sub-Committee have prepared two specifications for bindings. The first is for extra binding, suitable for valuable books, and the second for ordinary library binding, where strength and cheapness are of primary importance.

It is not contended that there are any new principles involved in these specifications. It has been the aim of the Sub-Committee merely to give some guide to the general principles of good binding.

Of the first specification for extra work little need be said. It gives a method of binding that was in general use up to the end of the 18th century, and is still used by the best binders.

This form of binding must be expensive, as it takes a long time to do. For most books a cheaper form is needed, and after examining and comparing many bindings that had been subject to considerable use, the Sub-Committee came to the conclusion that the bindings of books sewn on tapes with French joints generally fulfilled the conditions best.

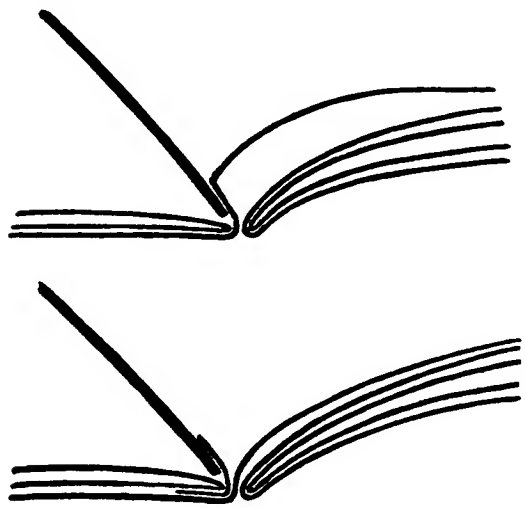


Fig. 5.—PLATES.

The first diagram shows in section a Plate pasted on to a leaf of a book. This method is faulty, because it takes up some of the back margin of the leaf; if the leaf is pressed back the plate is apt to split off.
The second diagram shows the method of attaching a Plate by means of a "Guard."

The points of advantage claimed for a binding carried out under Specification II. are—

(1) It need not be expensive.

(2) The construction is sound throughout.

(3) A book so bound should open well.

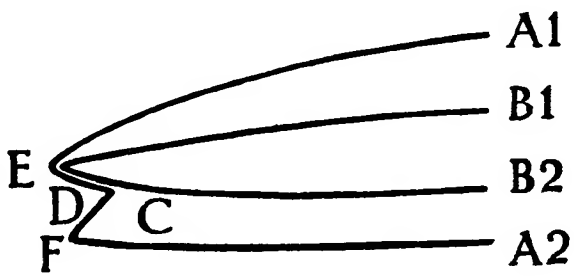
(4) The French joint enables comparatively thick leather to be used.

(5) In the absence of raised bands there is no reason for the undue stretching of the leather in covering.

(6) The backs of the sections are not injured by saw cuts.

Specification for Binding Heavy or Valuable Books.

Sheets and Plates.—All sheets broken at the back to be made sound with guards. Any single



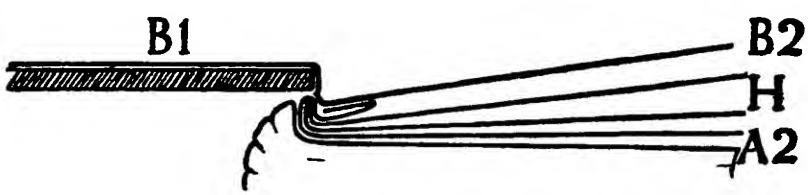


Fig. 6.—END-PAPERS.

Shows a Method of Making End-Papers with Fold to take the strain resulting from the opening of the board.

A1. Waste paper torn off before pasting-down.
B1. Paste-down paper.

An additional fold of plain paper is inserted at C, and sewn through at F
If a linen joint is used it can be inserted at D, and sewn through at E.
If marbled or other decorated paste-down papers are used they are "made" on to B1

leaves or plates to be guarded round adjoining sections. (Fig. 5.) Folded plates to be guarded with linen at folds. No pasting-on to be allowed.

End-Papers.—End-papers not to be pasted on or overcast, but to be made with stout linen joint and sewn on as a section. Some system of folding

or zigzaging, which allows a little play without danger of breaking away, is advocated. (Fig. 6.) End-papers to be made of good paper.

Sewing.—Sewing to be flexible, round the bands and all along the section. Thread to be unbleached linen, and bands to be of stout hempen cord and at least five in number. (Fig. 7.)

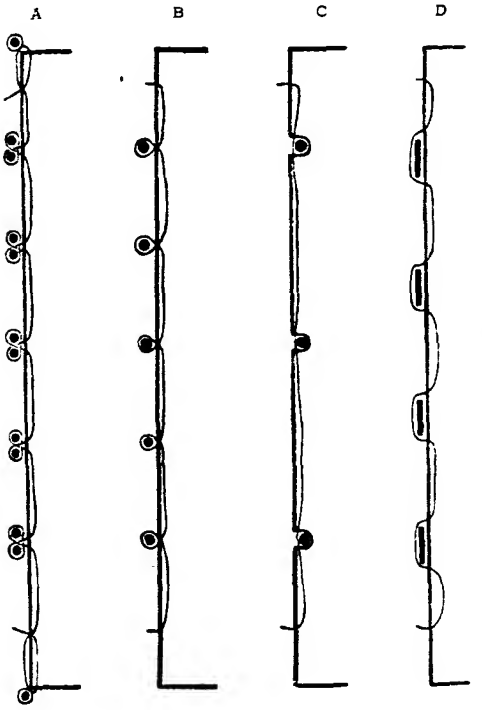


Fig. 7.—SEWING.

A. Section of 15th Century Sewing on double bands with head and tail bands.
B. ,, Modern "Flexible" Sewing round single bands.
C ,, Ordinary Sewing with sunk bands.
D ,, Tape Sewing advocated for cheap work in place of C.

Boards.—To be of best black millboard. The edge of the millboard in the joint to be slightly rounded. The sharp edge tends to cut the leather.

Lacing in Slips.—All five slips to be laced into each board and not reduced unduly. It would be better to sink places in the board to receive the slips than to weaken them by injudicious fraying out. (Fig. 9.)

Cutting.—This will depend on the librarian's orders.

Headbands.—Headbands to be worked on stout cord, vellum or catgut, with very frequent tie-downs, and to be firmly set with stout brown paper, linen, or leather.

Lining up.—If it is necessary to line up the back, it is best done with leather or linen, leather for preference.

Covering.—Leather not to be unduly pared down and not made very wet before covering. Care to be taken not to stretch the leather more than necessary. No hollow backs to be used, but the leather to be attached to the back.

Leather.—See Report of Scientific Sub-Committee.

Handles for pulling out of Shelf.—In the case of very large books that are likely to be much used, it is advisable to have a strap of leather going loosely across the back, and each end fastened to a board of the book. (See Fig. 4.) The Sub-Committee saw some such arrangement at one or two of the libraries visited, and it seemed that a great saving of the binding resulted from the use. The use of a metal shoe at the bottom of the boards of heavy books in constant use is also recommended (Fig. 4).

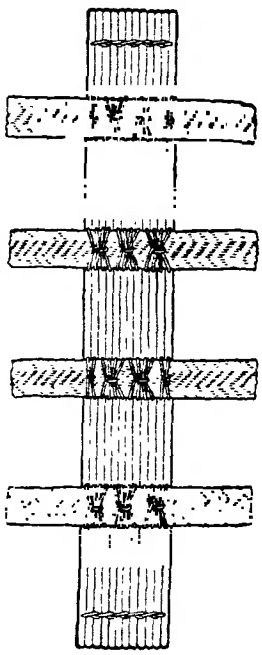


Fig. 8.
Showing a Method of Sewing on Tapes.
The catching up of the alternate groups of threads as they cross the bands renders the sewing firmer. There are other methods of achieving this end

Note.—Manuscripts on vellum, or books of unusual character require special bindings designed to meet the special conditions.

Suggested Specification for Ordinary Library Binding.

Sheets and Plates.—All sheets broken at the back to be made sound with guards, any single leaves or plates to be guarded round adjoining

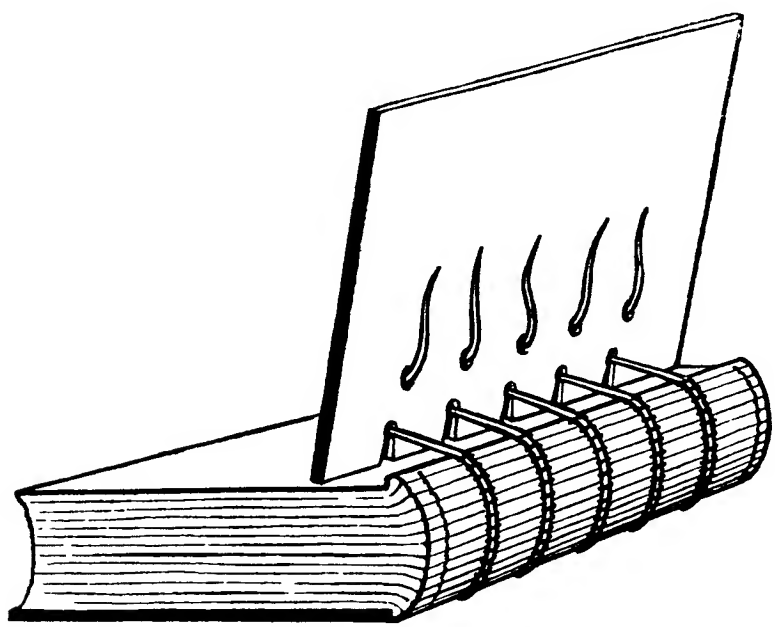


Fig. 9.—Showing the Method of "LACING IN" THE SLIPS on a "Flexibly" Bound Book.

If depressions are cut in the boards as shown, the slips can be left with an adequate margin of strength without clumsiness.

sections. (Fig. 5.) Folded plates to be guarded with linen at folds. No pasting-on to be allowed.

End-Papers.—To be of good paper sewn on. (Fig. 6.) No pasting-on or overcasting to be allowed.

Sewing.—To be sewn on not less than four un-

bleached linen tapes, with unbleached linen thread of suitable thickness. (Fig. 7, Fig. 8.) Books to be glued up and backed in the ordinary way.

Boards.—To be made "split boards," like those the vellum binders use. Grey board lined with a thin black board liner.

Cutting or Treatment of Edges.—To depend on orders.

Attaching Slips.—Slips to be pasted on to waste end-papers, which should be cut off about two inches from the back and inserted with slips in the centre of split board. (Fig. 10, Fig. 11.) The board to be left about one-eighth inch from the back of the book to form a French joint.

Head-Binding.—In cases where the expense of

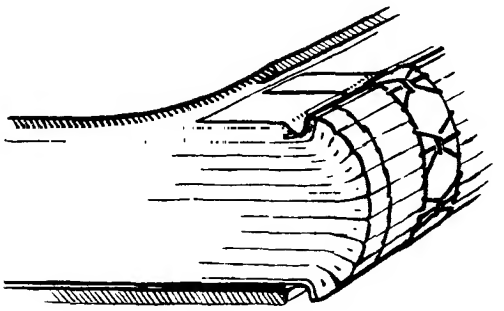
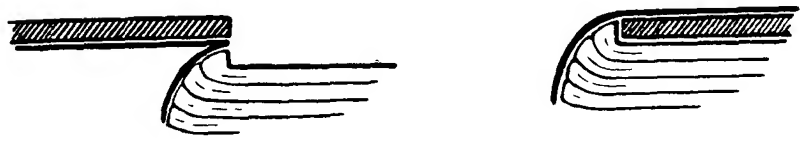


Fig. 10.—Showing Method of ATTACHING TAPE SLIPS TO A SPLIT BOARD, leaving a "French Joint."

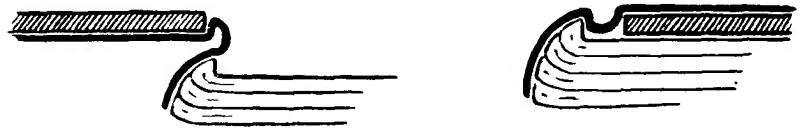
a worked head-band is thought to be too great, a piece of string may be inserted into the fold of the leather at the head or tail.

Covering.—Leather *not* to be unduly pared down. The French joint should make it possible to use far thicker leather than is usual. As there are no raised bands on the back the leather need

not be unduly stretched in covering. For small books leather from comparatively small skins that will need but little paring should be selected.



A Section of an Ordinary Joint with the board open shows that the creasing of the leather is concentrated on one line



A Section of a "French Joint" shows how this creasing is distributed over a great surface, and so enables sufficient flexibility to be obtained with much thicker leather than can be used with an ordinary joint

Fig. 11.—Showing the ADVANTAGE OF A "FRENCH JOINT" OVER AN ORDINARY JOINT.

PART III.—REPORT OF SUB-COMMITTEE No. II.

(Scientific)

M. C. Lamb.*
Dr. J. Gordon Parker. Prof. H. R. Procter.
A. Seymour-Jones.

IN presenting this Report, it was stated that its recommendations were based not only on considerable practical experience, but on a large amount of careful experimental work, carried out for the purpose of this enquiry. In re-editing for publication it has been thought desirable to include many details of these experiments which were originally only communicated verbally to the General Committee, so as to enable readers to form an independent opinion as to their importance.

The Report may be arranged under the following headings:

1. Nature of the Decay.
2. Causes of Decay.
3. Preparation of Leathers suitable for Binding.
4. Bookbinding.
5. Preservation of Books.
6. General Conclusions.

* Added in December 1902.

1.—*NATURE OF THE DECAY.*

The most prevalent deterioration noticed may be described as "red decay." This appears to vary somewhat in character according to the period of manufacture, the old red decay being noticeable up to somewhere about 1830, and the new decay, possibly slightly different in character, since that time. The character of the old red decay is a darkening of the fibres of the leather, which, while leaving the surface fairly intact and not easily abraded by friction, renders the leather hard and brittle throughout. The fibres of such leather are found, on microscopic examination, to be in a natural position although much weakened.

This form of decay is specially noticeable in books bound in calf presumably tanned with oak bark.

The newer red decay affects nearly all leathers, and, in extreme cases, seems absolutely to destroy the fibres.

Another form of deterioration, somewhat less frequent, renders the grain of the leather liable to peel off when exposed to the slightest friction. This is sometimes noticeable in the old period, generally without red decay, in the case of sheepskin, but accompanying red decay in calf. In modern leathers, since about 1830, the peeling of the grain is more common, and in quite modern leathers, subsequent to about 1860, it is one of the commonest forms of decay noted, especially in the case of grained morocco and sheepskin. It was also noticed in coloured and grained pigskins in a case in which

the texture of the leather had been so weakened by its treatment in the tannery that the Committee had great difficulty in believing that it was genuine pig-skin and not merely a sheepskin imitation, until it was submitted to careful microscopic examination.

In nearly all samples of Russia leather examined a very violent form of red decay, possibly peculiar to this leather, was noticed, the leather being found to be absolutely rotten in all parts exposed to light and air; so that on the very slightest rubbing with a blunt instrument it fell into fine dust.

In many cases, and especially in that of Russia leather, it was reported by librarians that leather on books that were in constant use lasted very much better than that on those which rarely left the shelves. An exception to this was noted in the case of the Patent Office Library, where nearly all the leather bindings, though very much handled, were in a very bad state. This may possibly be partly due to the fact that until about three years ago the books were kept in ill-ventilated rooms which were much used, and where very large quantities of gas were burned.

Further details as to the character and extent of the decay observed will be found in Part II. of this Report.

2.—*CAUSES OF DECAY.*

Observation having pointed to the fumes produced by the combustion of gas, direct sunlight, deficient ventilation, and tobacco-smoke, and certain processes and materials employed in leather manufacture, as being contributing causes to the decay which has been described, experiments were under-

taken to ascertain the nature of the action produced by each of these causes, and the susceptibility of various leathers to their influence. For this purpose calf, goat, and sheep skins were tanned out, one skin of each in each of the following tanning materials: pure sumach, pistacia lentiscus, tamarix, oak-bark, myrobalanes, quebracho, gambier, larch-bark, chestnut extract, and oakwood extract. When these skins were judged to be lightly but thoroughly tanned, one half of each skin was removed from the tan liquor, and the remaining halves were left in the liquors, which were strengthened up with more tannin, so that the second halves were more fully tanned, as is commonly the case in modern leather. The leathers so produced were rinsed through water to remove superfluous tan, allowed to drip, and when in a semi-dry condition were oiled lightly upon the grain surface, and hung up and dried in the usual manner. East India tanned goat, sheep and calf skins were also prepared, one set being washed, oiled and dried, the other set scoured, soured and sweetened, and retanned in sumach as carried out in practice. Pieces of each of these leathers were so fastened upon boards that one half of the piece was exposed, while the other half was carefully covered so as to be protected from light, heat, and the action of the surrounding atmosphere. In all, eight such duplicate sets were arranged, and were subjected to the following tests for thirty days:

Board No. 1 was exposed to ordinary direct sunlight. This was done in a large room facing south, and the tests were carried out during July and August.

Board No. 2 was exposed to the action of gas-

light. A small cupboard was arranged, and a No. 5 ordinary fish-tail gas burner was placed in the centre of the cupboard, and the boards so arranged round this that the leathers were about 3 feet from the burner.

Board No. 3 was arranged in a similar cupboard, and exposed to the light from an ordinary incandescent gas burner.

Board No. 4 was also arranged in the same way, but in place of the gas burner a 16-candle power incandescent electric lamp was used.

Board No. 5 was subjected to the fumes of burnt gas. To carry out this experiment a similar room was used, 8 feet high and 6 feet square. On the floor of this room was placed an ordinary fish-tail burner, turned about half on, and the boards with the leather fixed upon them were hung on the ceiling. A maximum and minimum thermometer was also hung on the ceiling, and the room so ventilated that the temperature was not allowed to exceed 90° F.; this being the temperature noted on the top shelves of two of the libraries which were examined; so that in this case the worst library conditions were imitated as closely as possible.

Board No. 6 was subjected to currents of moist and dry air alternately, which were drawn over the leather through a closed vessel kept at a temperature of 60° to 70° F.

Board No. 7 was subjected to an atmosphere of carbonic acid gas. This test was likewise carried out in a closed vessel, the carbonic acid gas being dried before it was admitted.

Board No. 8 was subjected to direct sunlight, but the leather was protected from the air by a

sheet of glass being laid upon it. This was exposed at the same time and in the same room as board No. 1.

The leather after this treatment gave some most interesting and instructive results. It showed—

1. That leathers tanned with certain tanning materials were less affected than those tanned with others.

2. That the fumes of burnt gas appeared to act more strongly than any other agent on all the leathers.

3. That artificial light had only a slight effect upon the leather, provided the latter was protected from the products of combustion.

4. That direct sunlight and air appeared to have a very strong disintegrating action upon most of the samples, but that when the leather was protected by a covering of glass the action was less intense.

5. Moist and dry air appeared to have no special deteriorating action. The same thing was noticed in the set exposed to carbonic acid gas. The electric incandescent light appeared to have even less effect than either ordinary gas-light or the incandescent gas burner, probably on account of the smaller amount of heat evolved and the absence of products of combustion.

On examining all these sets side by side it was noticed that in each case the leathers tanned with sumach and those tanned in galls were the least affected of any, followed in order of merit by myrobalanes, chestnut extract, oakwood extract, oak bark, gambier, larch bark, quebracho, pistacio and tamarix; while the worst of all were the East India leathers tanned with turwar (Cassia) bark, and

especially the sample which had been scoured, soured and retanned. Further, it was also noted that the samples of leather which had been only lightly tanned were less affected in each case than those which had received a longer time in stronger tanning material. These results showed that the tannins which belonged to the pyrogallol class of tanning materials, viz. sumach, myrobalanes, chestnut and oakwood extracts, were the least affected; while, on the other hand, those of the catechol series, represented by gambier, larch bark, quebracho and turwar bark, became dark red in colour and hard in texture; and the fibres of the leather appeared to be disintegrated. In the worst cases the leather could not be rubbed even with a soft cloth without removing a layer of red powder. The tannins of the catechol series are known to part readily with water when exposed to the action of light, heat, or acids, and are converted into red, resinous-like substances which appear thoroughly to disintegrate the fibres of the leather, causing it to become hard and to lose all strength.

These experiments were separately carried out and confirmed by repetitions at Leeds, Wrexham, and London, so that there can be no question of their substantial accuracy. A similar set was treated for sixty days, and some leathers were exposed for three full months, always with the same sort of result. In all the experiments made, sumach-tanned leathers proved the least affected; and the East India tanned skins, whether sheep, goat, or calf, the most sensitive to either gas fumes, light, or heat.

To test these latter goods further, an ordinary

tanned East India goatskin and sheepskin were purchased in the usual manner, and each skin divided into four parts. A quarter of each was left in its original state as purchased ; a second quarter was rinsed through water, lightly pressed out, oiled and dried ; a third quarter was scoured in alkali, then washed through sulphuric acid, afterwards well rinsed in water and then retanned in sumach ; and the fourth quarter was simply washed well in water, struck out, and afterwards retanned in sumach. Portions of these pieces were subjected as before to the action of gas fumes, to direct sunlight, and to diffused daylight for sixty days. Each sample was more or less affected. The samples which had been stripped with alkali, treated with acid, and afterwards sumached, showed most deterioration. Those portions exposed to the action of burnt gas fumes were absolutely rotten at the end of the time, and could not be handled without breaking or falling into powder. The best sample was that which had been simply washed in water, oiled and dried, but even this was badly damaged, and turned a deep red colour, though it showed that the removal of some of the tannin tended to lengthen the life of the leather ; while, on the other hand, the usual trade custom of stripping with an alkali and souring with acid, afterwards retanning in sumach, appeared to lessen by one half the already short wearing life of these leathers.

In order if possible to determine the cause of the decay in modern oak-bark tanned calf, several samples of tanned calf skins were purchased and obtained from librarians and bookbinders. Although none of this leather had been used or exposed in

libraries, it was found that most of the samples contained varying quantities of free sulphuric acid which had evidently been used to brighten the colour. Special samples were therefore obtained free from sulphuric acid. Portions of each of these skins were subjected to the method of testing already described, with the result that while acid-free leathers stood the tests in a satisfactory manner, the samples which contained quantities of sulphuric acid, varying from two-tenths to eight-tenths of 1 per cent., changed to a red brown colour, became hard and brittle, and were easily abraded by friction.*

This custom of brightening the colour of bark-tanned calf by the use of sulphuric acid is of comparatively recent date, probably becoming general twenty or thirty years ago. It has a wonderful effect upon the leather, removing iron and tan stains, and unevenness in colour, generally brightening the somewhat reddish tone, and transforming it into one of a yellower shade, and thus giving to the skin a better appearance from the buyer's standpoint.

* No simple process for the detection of traces of free sulphuric acid in leather has yet been suggested which can be carried out without chemical knowledge. For accurate determination that of Wünsch (Wiss. Beilage des Ledermarkt 1901, pp. 141–147) is most to be recommended, while Procter and Searle's method (Wiss. Beilage 1901, p. 65) is simple and reliable with careful manipulation, but in presence of sulphates of iron, alumina, or ammonia may give misleading results. It is best carried out as follows :— 4 grm. of the leather is placed in a platinum or porcelain basin, and moistened with 20 c.c. of N/10 sodium carbonate solution and evaporated to dryness on the water bath, and then gently ignited till completely carbonised, but not reduced to a white ash. The residue is powdered and treated with 30 c.c. of N/10 HCl, made up to 100 c.c., 50 c.c. filtered off, and titrated with N/10 soda solution in presence of methyl orange. The excess of soda solution which is required over 5 c.c. represents the free sulphuric acid of 2 grm. of leather and each c.c. of soda solution over 5 corresponds to 0·245 per cent. If less than 5 c.c. is required it simply indicates the presence of lime or some other alkaline bases in the leather, and may be disregarded.

Further tests with bark-tanned calf showed that the more heavily it was tanned the more rapidly it appeared to decay.

The experiments thus far were made with rough-tanned skins only. It was now necessary to enquire whether the ordinary methods of dyeing and finishing leather in any way impaired its wearing qualities. For this purpose calf, sheep, goat, seal, and pig skins were obtained in the rough or "crust" condition, and each skin was divided into four portions, of which the first was retained in its rough tanned state; the second was struck out, dyed, freed from superfluous dye by rinsing in water, and dried out; the third portion was struck out, dyed and finished in the usual manner, being glazed by friction after applying an ordinary albumen seasoning, no acid being added to the dye-bath to develop the colour; while the fourth portion was similarly struck out, dyed with the addition of an ordinary amount of sulphuric acid, and finished as before. These series were, as before, exposed to direct sunlight and to the fumes of burnt gas. The results showed that the dyeing of the leather, where no acid had been used, did not in any way affect its durability. The finishing appeared to protect the surface of the leather somewhat, as was perhaps to be expected, as the leather is covered with a thin layer of albumen, which to a certain extent protects it from air and gas fumes. The portions of the skins with which acid had been used in the dye-bath showed signs of decay, and had become hard and brittle. Of the five different skins used, the calf and sheep appeared to be the weakest, while the goat, seal and pig skins appeared the least affected by the tests.

In order to ascertain how far the use of sulphuric acid, as a brightening agent or in the dye-bath, had become universal, we collected from various sources a large number of samples of different leathers. Out of 38 different samples of moroccos, 36 contained free sulphuric acid; 18 different samples of skivers were examined, of which 12 contained acid; 32 samples of calf, out of which 27 contained acid; 18 "Persian" (East India) goat and 25 "Persian" sheep were also examined, and in all cases free sulphuric acid was found to be present. Six different samples of pig skin were tested, and in each free acid was found. These various samples were all of English manufacture, some obtained direct from the manufacturers, others from leather merchants and bookbinders.

Knowing that of recent years a large quantity of French and German skins had been used for binding purposes, eight different samples of French levant moroccos were obtained, and in each of the eight samples a large quantity of free sulphuric acid was found; the lowest containing 0·6 per cent. and the highest 1·3 per cent. of acid. Twelve samples of German bookbinding leather were in like manner tested, and eleven found to contain acid, the highest percentage found being 0·85 per cent.

It is evident, therefore, that sulphuric acid is in almost universal use, either as a brightening agent, or to liberate the dye in the dye-bath.

As it is always customary in tanyards to rinse the skins well through water after souring with acid, it was somewhat surprising to find so high a percentage of free acid still present in the finished leather. Tests were therefore undertaken to ascer-

tain the amount of washing or rinsing necessary to remove the acid. To this end several pieces of skin were treated with known quantities of sulphuric acid, and then washed for varying periods in running water. It was found to be practically impossible to remove the whole of the acid by rinsing or washing in ordinary water. One piece of "Persian" leather, containing 1 per cent. of sulphuric acid, was washed for five days and nights in running water, and at the end of that period it was found that it still contained slightly over two-tenths of 1 per cent. of sulphuric acid, showing that sulphuric acid, as stated in Prof. Procter's Cantor Lecture, delivered before this Society, appears to dissolve in the leather and adheres most tenaciously to the fibres. It was, however, found that if skins were washed in water containing either potassium or sodium lactate or acetate, the free sulphuric acid was neutralised; where, therefore, it is absolutely necessary to use sulphuric acid the Committee recommend that this means of neutralisation be adopted.

Another process by which sulphuric acid is introduced into skins is that known as "pickling," by which pelts are treated to render them capable of preservation and transit in the wet untanned condition. This process is applied to many skins shipped to this country from New Zealand and Australia, which are treated in a solution of salt and sulphuric acid. Several of these skins were tanned and compared with unpickled skins, and it was found that the leather produced from skins which had been pickled was much inferior in strength and durability to the unpickled.

It has been proved that the acid so introduced

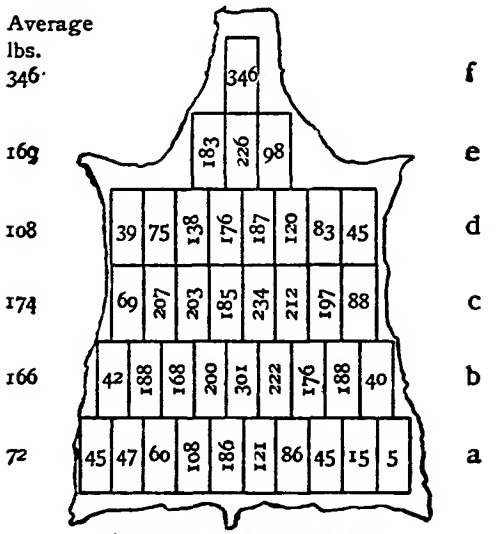
is never wholly removed in the subsequent tanning, but Mr. A. Seymour-Jones has shown that the use of formic acid in place of sulphuric is free from these objections, and skins preserved in this way have stood the severe test of twice crossing the equator in a voyage to Manaos, 1000 miles up the Amazon and back, and have subsequently yielded perfectly satisfactory leather.

Low liming and the use of stale limes containing quantities of free ammonia were found to weaken the pelt, as also over-puering, a process which is used to rid the skin of lime, and at the same time to pull down its thickness, and to make it soft and pliable. Many of the finished leathers examined microscopically showed that the skins had been distinctly over-puered. This was very noticeable in a series of pig-skin bindings of one of the large public libraries.

In order to determine the way in which the skin was affected as regards mechanical strength by the various processes which it underwent, Mr. A. Seymour-Jones made a series of experiments on lamb skins selected in the limed condition as nearly as possible of equal growth, thickness, and character. Each of these skins was divided into a large number of pieces, 6 inches by 2 inches, which were narrowed to 1 inch in the centre, and the amount of weight in pounds required to break each of these strips at the narrowest point was determined in an ordinary testing machine. The illustrations show the positions from which these strips were cut and the stresses at which they broke.

No. 1 represents a lamb skin, which after liming was simply cleansed from lime by drenching as it

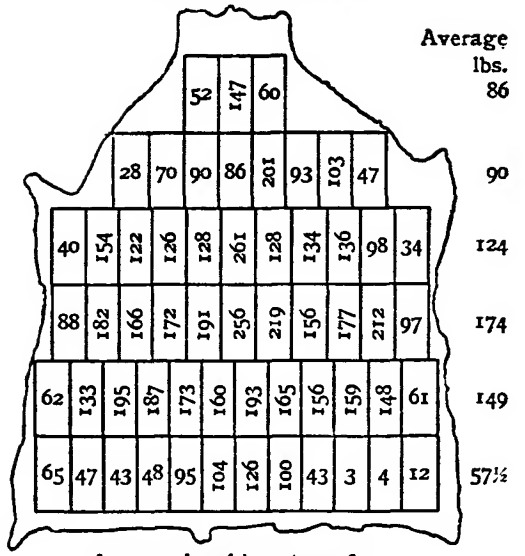
Breaking Stresses.



Average breaking stress for whole skin, 136 lbs.

No. 1.

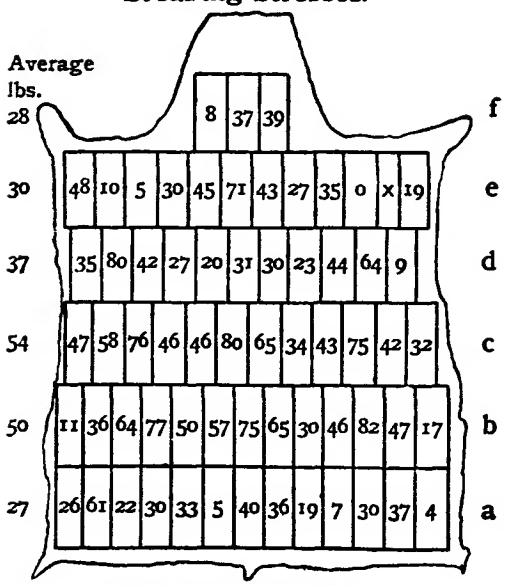
Breaking Stresses.



Average breaking stress for whole skin, 118 lbs.

No. 2.

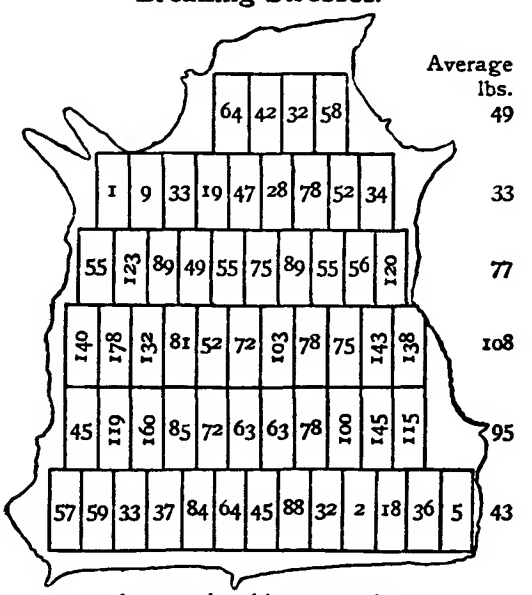
Breaking Stresses.



Average breaking stress for whole skin, 39 lbs.

No. 3.

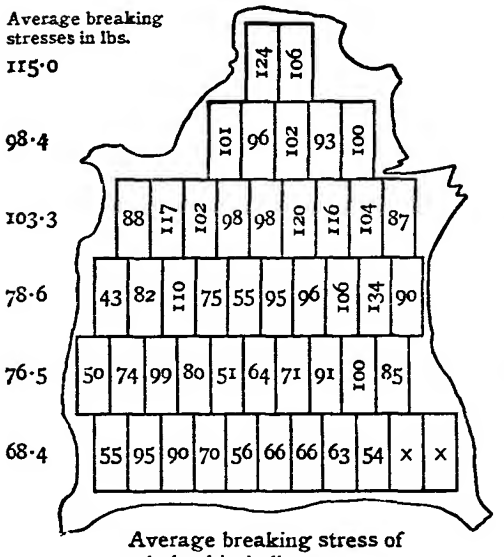
Breaking Stresses.



Average breaking stress for whole skin, 70 lbs.

No. 4.

Breaking Stresses.

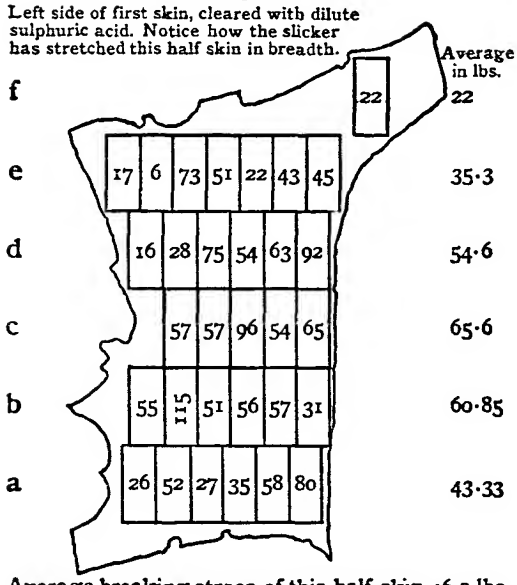


Average breaking stress of whole skin in lbs. 93·3

No.5.

Breaking Stresses.

Left side of first skin, cleared with dilute sulphuric acid. Notice how the slicker has stretched this half skin in breadth.



Average breaking stress of this half skin 46·9 lbs.

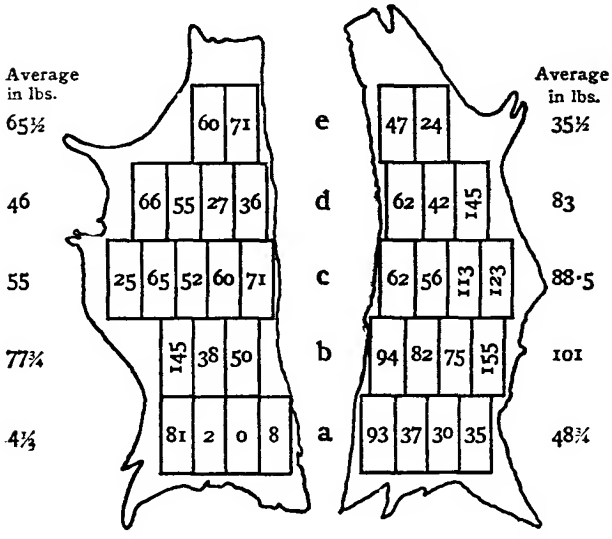
No.6.

Breaking Stresses.

Right side of first skin, sponged four times on the grain with Peroxide of Hydrogen. Notice how the slicker has stretched this half skin in length.

Breaking Stresses.

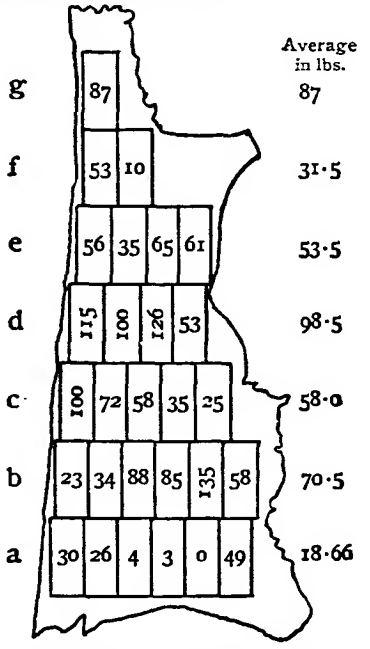
Left side, cleared. Right side, not cleared.



Average for left side of skin, 46·5 lbs.

Average for right side of skin, 75 lbs.

No.7.



Average breaking stress of this half skin, 59·6 lbs.

No.8.

would be in preparation for tannage, but which was dried out in the raw state. It will be noted that the stresses withstood by this skin are much larger than those in any other series of experiments, and that therefore no part of the tanning process increases the mechanical strength of the skin. It will be seen from Nos. 2, 3, 4, and 5 that the skin does not improve in strength as we proceed with its manufacture. This is perhaps to be expected since in the simple dried skin the fibres adhere together and mutually support each other, leaving the skin hard and horny, while the main object of tanning is to separate and isolate the individual fibres, leaving the skin soft and porous and suitable for its uses, but diminished in tensile strength. Over-tannage of any sort materially reduces the tenacity and wear of all sorts of bookbinding leather.

Fig. 2 represents a similar lamb skin tanned out in oak bark, the average breaking stress being reduced in this case from 136 lb. to 118 lb. only.

Fig. 3 represents the effect of retanning after shaving in order to improve colour, a method which is condemned emphatically in our report, and which further reduces the average breaking stress to 39 lb.

Fig. 4 is a skin similarly tanned to No. 1, but afterwards shaved, and the extraordinary diminution to an average of 70 lb. breaking stress shows the very great weakening caused by the removal of the inner fibrous layer of the skin by shaving.

Fig. 5 again represents a similar skin prepared in the same way as No. 3, but subsequently by the use of an oil in striking, and by softening, increased in resistance to breaking stress to 93·3 lb. It may be pointed out that, although this improvement is

considerable, the skin is not equal in strength to that of the rough skin in Fig. 2, which represents the condition in which it is recommended that bookbinders should obtain their stock.

Figs. 6, 7, and 8 represent a series of experiments undertaken to test the effect of bleaching or clearing with acid. In Fig. 7 the difference of strength in favour of the side not treated is extremely marked. Nos. 6 and 8 are an attempt at comparison between the effects of sulphuric acid and of hydrogen peroxide as bleaching agents, resulting only slightly in favour of the latter. The two halves have been struck out, one lengthwise and the other diagonally, and the extension of the skin in the different directions is very marked.

It may be questioned, however, whether this extension has not had some effect as regards the comparison in strength of the two different methods of bleaching.

3.—*PREPARATION OF LEATHERS SUITABLE FOR BINDING.*

The causes of decay which have been pointed out in the foregoing pages, while partially due to the conditions under which books are kept, must also be attributed in no inconsiderable degree to methods of manufacture which are capable of improvement, or which, while successful in producing leathers of good appearance, have been adopted by manufacturers and bookbinders in ignorance of their detrimental after-effects. The following remarks on the manufacture of the leather will, therefore, not be out of place. Of course, it is not

possible within the limits of a report in all cases to give the experimental proofs which have led the Sub-Committee to the conclusions which follow, but they are the result not merely of laboratory experiment, but of much practical experience, and of many tests on a maufacturing scale.

Raw Skins.—We are of opinion that no special skin can be condemned in its original condition, although goat, seal, pig, and calf are superior in strength and closeness of texture to sheep. Sheepskins are, however, equally resistant to chemical agencies, and being naturally soft and flexible, are extremely suitable for use for purposes where they are not much exposed to mechanical wear.

Cure.—Fresh market skins, dry skins, or wet salted skins are much to be preferred to those known as "drysalted," since the crystallisation of the salt which takes place in the dry-salting process, tends to weaken the structural fibre of the pelt. No tainted or putrefied skins, even if only slightly affected, are suitable for the manufacture of bookbinding leather, both for the same reason, and because the weakness of grain so produced leads to uneven dyeing. Dry skins are much more liable than fresh or salted ones to hidden defects which only appear during manufacture or use.

Soaking.—In the soaking of skins we would strongly condemn the use of old putrid soaks, or the addition of salt to the soaks to assist in the softening, as both methods weaken the skin. We would recommend, in preference, a plentiful change of fresh water, and in the case of obstinately hard skins the addition of sodium sulphide to the extent of two parts per thousand of the soak water.

Violent mechanical treatment such as "stocking" is injurious, but moderate drumming with cold or tepid water may be permitted.

Liming.—The liming should be done in mellow weak limes. Old limes smelling strongly of ammonia, and containing large quantities of bacterial products, must be avoided. The addition of small quantities of sodium sulphide or arsenic sulphide to the limes is often advantageous, and shortens the time required.

Special care should be taken with regard to the beam-house work after unhairing and fleshing, as by excessive or unsound puering and drenching of the skins, their whole natural strength is frequently destroyed. We have examined many samples of leather, both on and off books of recent manufacture, of which the decay has been due to improper beam-house work. Great damage is frequently caused by the use of foul puers or foul bates, in which putrefaction has taken place.

Attention may be drawn to a bacterial substitute for the uncertain dung bate which has recently been put on the market, under the name of Erodine, and which has for some considerable time been used with great success in many works at home and abroad. After experimenting somewhat extensively with this substance, we are strongly of the opinion that this process of puering is very much safer, and is to be recommended in preference to the old method, than which it is not more expensive. In principle it consists of a suitable nutriment for a pure culture of bating bacteria, which is supplied with it.

The partial or entire removal of lime by purely chemical means, such as the cautious use of the

milder acids (boracic, formic, lactic, and acetic, as well as some acids of the coal-tar series), or of neutral salts, such as those of ammonia, which replace lime by a weaker and more soluble base, is in many cases to be recommended; not so much as an entire substitute for fermentative purposes—such as puering and drenching—as in lessening the extent to which it is necessary to carry the action of the latter, and thus reducing the risks of injury, which are always present where putrid fermentations can take place. It must, however, be pointed out that more care and scientific knowledge are necessary for the successful use of purely chemical means than is always possessed by the average tanner.

Tanning.—The vegetable materials now used in the tanning of leather are very varied, and their active constituents, the tannins, form a class, which, though possessing the common property of converting the raw skin into leather, differ widely in their chemical constitution and properties. Largely on account of their uncrystallisable character, and the consequent difficulty of separating them in a state of purity, the details of their chemical structure are still very imperfectly known, but it is clear that they may be broadly divided into two groups, one of which contains the dihydric phenol *catechol* as its principal constituent, while the other is similarly derived from the trihydric phenol *pyrogallol.* Though the members of each of these groups present considerable differences among themselves, they are marked by common characteristics of considerable importance. Chemically they are easily distinguished by their reaction with bromine water, since the catechol tannins, even in very weak solu-

tion, become turbid, or form a precipitate of insoluble bromine derivatives, while solutions of pyrogallol tannins remain clear. They may also be distinguished by the colour of their compounds with ferric salts (best seen on the addition of a very weak solution of iron-alum), the catechol tannins usually giving a greenish black, while the pyrogallol tannins produce blue blacks. To this rule, however, there are some apparent exceptions, possibly due to impurities. Practically the pyrogallol tannins are known to the tanner as yielding leathers with a greater or less deposit of "bloom" caused by deposition on the fibres of insoluble ellagic acid, while the catechol tannins give no bloom, but usually deposit reddish resin-like substances ("reds"), which are apparently produced from the tannins by the loss of water, and possibly by oxidation. This change is probably closely related to the "red decay" to which leathers produced by these tannins are particularly liable, and which has been more than once alluded to as the most serious cause of damage to leather bindings. This decay is hastened by the action of heat, sunlight, and the presence of traces of acids, or probably by any circumstances which tend to remove chemically combined water from the tannin, until the leather, though originally strong and tough, entirely loses its tenacity, and, in extreme cases, falls to powder. On this ground, the tannins of the catechol class are unsuitable for the production of leathers for bookbinding and upholstery, however valuable for shoe manufacture and other purposes where resistance to mechanical wear is of more importance than prolonged endurance of the effects of time in a dry atmosphere.

The principal catechol tannins which come into consideration in the production of the lighter leathers are those of the American hemlock pine, the larch, and the spruce fir used in Continental tanneries, quebracho, the Australian and Indian mimosas and acacias, the various mangroves, and, not least important, the Turwar bark *(Cassia auriculata)*, so largely used in the tannage of East Indian sheep-skins and goat-skins. It is also to be noted that pistacio, and most other common adulterants of (or substitutes for) sumach belong to the same class, and tend to cause decay.

The most characteristic representatives of the pyrogallol tannins are the various gall-nuts (from which gallotannic acid is obtained, and which also have a limited use in tanning), sumach and myrobalanes. Valonia, divi-divi, and oak-wood and chestnut extract are also pyrogallol tannins, while oak-bark seems to occupy a sort of intermediate place, though its purified tannin certainly belongs to the catechol group.

Some of the catechol tannins, such as turwar bark, give a pale yellowish tannage, though the majority incline to a reddish tinge; but an unfailing characteristic, which is even most marked in those of lightest colour, is the reddening which takes place in the leather when exposed to sunlight. Some indeed, like the Indian, or so-called "Persian" sheep and goats, are so sensitive that a print may be obtained on them by exposure under a photographic negative for a few days to good sunlight. Oak-bark darkens much less than any other of the catechol tannins in sunlight, rather becoming brown than red, and in resistance to the effects of time,

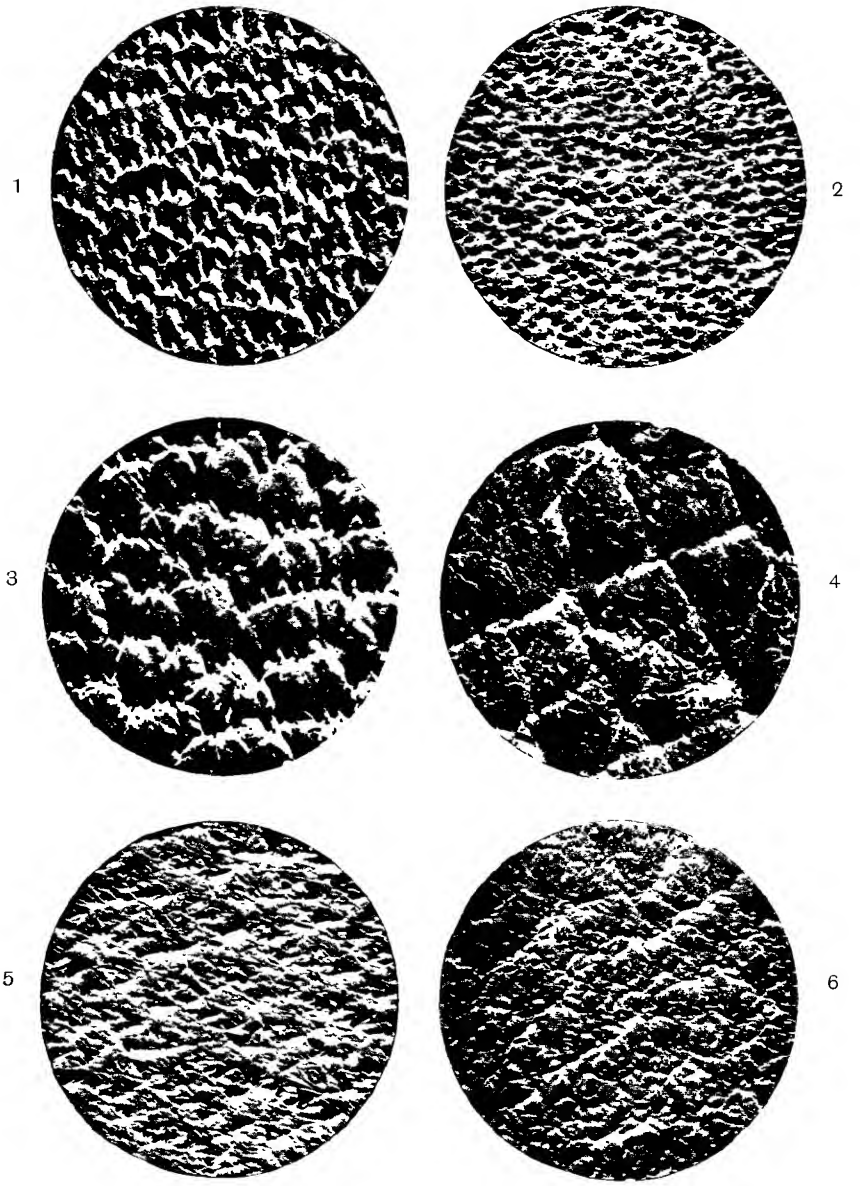
heat, and acid fumes, it approaches closely to the pyrogallol group. The true pyrogallol tannins, such as sumach, do not redden at all on exposure to light, though they may slightly darken by oxidation; and when sumach-leather shows signs of reddening, it is a strong presumption that the sumach used has been adulterated, as is very customary, with pistacio or some other catechol tannin. It must be remembered, however, that gallic acid, the first decomposition product of the sumach tannin, is converted by the action of concentrated sulphuric acid and heat into a red body, rufigallic acid, very similar in appearance to the reds of the catechol tannins, and closely related to alizarine, and it is not impossible that some similar change may occur in acid leathers.

Of the pyrogallol tannins, gall-nuts and pure sumach have, in the very numerous experiments of the Sub-Committee, proved most resistant of any of the various tanning materials tested to the destructive action of light, heat, gas fumes, and oxidising agents, and are therefore to be most strongly recommended for all the purposes of high-class bookbinding and upholstery. It is almost certain that the early Italian moroccos which have shown such remarkable permanence are of pure sumach tannage, and the Niger goat-skins are said to be tanned with some sort of gall-nut. Very similar skins produced in the Sudan are tanned in a decoction of the acacia pods (introduced as a tanning material into this country under the name of "Gambia pods"), which also contain a pyrogallol tannin. Gall-nuts have long been known as a tanning material in the East, and though the Turkish gall is too costly for ordinary tanning purposes, other oak galls (Rove,

Knoppern), as well as galls from various species of tamarisk and sumach, have been considerably used for tanning purposes.

On the other hand, from reasons which have been already explained, catechol tannages, however valuable for general purposes, are unsuitable for bookbinding and upholstery, and this is specially true of the cassia bark tannage of East Indian or so-called "Persian" skins, while quebracho, mimosa, hemlock bark, and *pistacia lentiscus* are almost equally deficient in resistance to the "red decay" caused by time and exposure to light, gas-fumes, and acids. In certain classes of leather, however, among which seal and pigskin may be specially named, as well as calf and sheep for some kinds of binding, it is found impossible to get sufficient firmness and solidity by the use of sumach only; and in these cases the use of oak bark, alone or in mixture with sumach, may be recommended; as it has been proved that a slow bark tannage is scarcely inferior to sumach in resistance to decay, while surpassing it as regards mechanical wear. Chrome leathers produced by basic salts of organic acids and free from mineral acids and sulphur, and combinations of such chrome tannages with pyrogallol tans, have stood satisfactory tests; and while time alone can prove their durability, it is very probable that it may exceed that of vegetable tannages. Their use in bookbinding must, however, be regarded as to some extent experimental.

Whatever tanning material is used, it is important that the process should not be carried too far. The object of tanning is simply to preserve the animal tissues of the skin from decay, and to in-



PHOTOMICROGRAPHS OF GRAIN OF VARIOUS SKINS

(A. Seymour-Jones.)

1. Cow Hide. 2. Calf Skin. 3. East India Goat. 4. Pig Skin.
5. East India Sheep. 6. Welsh Sheep.

crease its resistance to water. The tanning process has throughout a hardening effect on the fibre, which diminishes its toughness, and, if pushed to its extreme, ends in brittleness and loss of tenacity. Many samples of old leathers which are still in a good state of preservation have been tested by the Sub-Committee, and in all cases they have been found to show a smaller proportion of tannin to hide fibre than is common to modern leathers, while in many cases overloading with tannin has been found to be an actual cause of decay. The practice of retanning or re-sumaching already tanned leathers to give additional softness and fulness is specially objectionable.

The use of strong mineral acids, either during the tanning process or for the preservation of the skins before tanning ("pickling"), is to be strongly condemned, as it is found that once the skin is swollen with acid the latter can never be completely removed, and will ultimately have a destructive effect on the leather. Mr. Seymour-Jones has shown that either formic or acetic ("pyroligneous") acid can be substituted for sulphuric acid in pickling with safety and success (see p. 49, and "Collegium" 1904, p. 186). The presence of small quantities of weak organic acids in the tanning liquors is necessary to the tanning process, but excess even of these may be very injurious.

The use of acids, and especially of mineral acids, to an extent producing fulness or plumpness in the skins in the tanning process must be absolutely avoided.

As a rule the tanning of leather where durability is required should not be hastened by the use of too

strong liquors, which have a tendency to overtan the surface before they have sufficiently penetrated the interior of the skin. Where drums are used to hasten the process, care is needed that the skins do not become overheated by the heat developed by friction.

After tanning, the goods should be washed up by merely drawing through clean water to remove any adhering tan liquor, and then laid in pile to drain into semi-dry condition. After oiling on the grain side, they may be dried out, and after this process they should on no account receive more tanning in any subsequent operation. Any additional mellowing effect required should be attained when dried after dyeing, either by suitable application of a non-acid oil or fat-liquor, or by softening on a table by means of the slicker or boarding.

Finishing.—Shaving, if done at all, should only be to a limited extent, since, however it may be carried out, it necessarily weakens the skin by removing its toughest parts, and therefore, for small books, thin skins should be chosen, so as to avoid the necessity of paring down, while for larger ones a larger and stouter skin may be used. Librarians and bookbinders must realise that they cannot have a large thin skin which will last, since the thin substance can only be secured by shaving (or splitting, which is still more weakening). If this rule is followed, then the shaving is simply reduced to "necking" and "backing," to equalise the thickness of different parts, and to remove loose adhering flesh.

Care is also required in the operation of "fluffing" (reducing substance and smoothing the flesh side of

the skin on a revolving wheel coated with emery), since not merely mechanical injury may result from careless work, but the strength of the fibres may be lessened by the very considerable heat produced by friction.

We do not approve of the method of drying skins tacked out tightly on boards, as the object should be to retain the fibres in their naturally felted and sinuous condition. If the skins are shaved, they are stretched out in the operation, and the fibres get laid flat and straight. This condition is subsequently increased in the wet-setting out, and the fibres finally permanently fixed by drying tacked out on the board. This horizontal position does not admit of any play or elasticity in the fibres, which is especially necessary in that part of the book which forms the hinge between the back and the side. Again, if the fibres are retained unstretched, they form a sort of elastic cushion, and wear only on the surface, and as the surface layer contributes little to the strength of the leather, the injury even after many years is inappreciable. If the fibres are in a state of strain they present a horizontal surface to the back and sides of the book, and the wear comes upon the side of the fibres, which give way and break successively.

These statements are supported by the fact that much of the leather which is at present in good condition on old books was manufactured before the introduction either of the slicking, shaving, or setting-out tools, and microscopic examination of this leather reveals the fact that its fibres are in a much more erect condition than those in modern leather. In further confirmation, several skins were

tanned, and portions of each were finished differently, and it was found that those which had not been severely stretched had greater strength, pliability and durability than the leather from the same skin which had been tightly set out, shaved, and dried in the strained condition, as is common in modern leather manufacture. For similar reasons the embossing of leathers by heavy pressure under plates and rollers must be condemned for all good work, not only as artistically a sham, but as actually injuring the texture of the leather. Where a grained or "pebbled" surface is required it should be that natural to the skin employed, and merely developed by the process of "boarding."

Dyeing and Finishing.—We cannot condemn any special group of dye-stuffs, but manufacturers must select those which are fastest to light and air, and which can be applied without the use of strong acids or dangerous mordants. Many of the coal tar colours answer this test, as do some of the wood dyes. But, on the other hand, very many colours, both natural and artificial, are absolutely fleeting on even short exposure to light, and others can only be applied by the use of methods injurious to the leather.

A supplementary report on the subject of leather dyes and dyeing has been made by Mr. M. C. Lamb, Director of the Leather Dyeing Department of Herold's Institute, who has been added to the General Committee since the original publication of this Report. Mr. Lamb's report, which contains much valuable and detailed information, especially as to the permanency of dyes on leather, is given in Appendix II. (see p. 77), and it is therefore un-

necessary at this point to do more than refer to a few points of general importance.

The use of any but mild organic acids in souring or scouring the leather, or in the dye-bath, must be absolutely condemned where durability is the first consideration, and the use of alkalies or alkaline salts is equally injurious.

It has been shown by careful experiment, that even a minute quantity of sulphuric acid, used in the dye-bath to liberate the colour, is at once absorbed by the leather, and that no amount of subsequent washing will remove it. In a very large proportion of cases the decay of modern sumach-tanned leather has been due to the sulphuric acid used in the dye-bath, and retained in the skin (see p. 47).

We have manufactured leathers with and without the use of acid, and have exposed these leathers to different tests side by side. In each case the sample treated with acid has decayed within a very short time. Formic acid may in most cases be substituted in the dye-bath for sulphuric with much greater safety and with equally good results.

Metallic salts of mineral acids should as a rule be avoided as mordants, and the use of bichromate of potash, or sulphate of iron, for dulling colours must for similar reasons be condemned. Iron salts are always injurious to leather, but if used at all, those of weak organic acids (acetates, lactates, etc.) are least objectionable. Some of the old blacks produced with iron dissolved in sour beer, cider, or vinegar, have lasted well, but iron-logwood blacks are never permanent. Several aniline blacks are

fairly fast and do not injure leather, and may be satisfactorily used for shading.

The skins on leaving the dye-bath should be well rinsed, to free them from excess of dye, and then finished. If mineral acids must be used in clearing or dyeing, the addition of a little acetate, lactate, tartrate or citrate of soda or potash to the washing water lessens the risk of future decay. Some experimenters seem to have obtained satisfactory results with formic acid as a clearing and bleaching agent, but Mr. Lamb has pointed out that its power of removing iron stains is much inferior to that of sulphuric acid.

We make no special recommendations in finishing, except that a tight setting-out of the fibres must in all cases be avoided. The staking, perching, and graining may be carried out as is usual. We should, however, advise that the glazing of skins by friction in a damp "seasoned" condition should be avoided. Simple seasonings containing either blood or egg albumen, Iceland moss, or other similar mucilages, may be used, but no strong acids or alkalies must ever enter into their composition. The use of nitric acid as a preparation for glazing is absolutely destructive.

When glazed and regrained, the skins may be lightly oiled over with an oil free from acid, and they are then ready for the bookbinders' uses.

4.—*BOOKBINDING.*

We leave the mechanical part of bookbinding to other members of the Committee, but there are several chemical points which we must touch upon.

The use of oxalic acid for washing backs of books, or of leather for bookbinding, is fatal to their durability. Vinegar, even in its pure state, is injurious, but many bookbinders use a very crude wood-vinegar, containing tarry products, which make its use still more detrimental to the leather. The presence of sulphuric acid in the vinegar used should be guarded against.*

The sprinkling of leather with ferrous sulphate (green vitriol), either for the production of "sprinkled" calf or "tree" calf, must be most strongly condemned, as the iron combines with and destroys the tan in the leather, and free sulphuric acid is liberated, which is still more destructive. Iron acetate or lactate is somewhat less objectionable, but probably the same effects may be obtained with aniline colours without risk to the leather.

The egg-glaires used by bookbinders certainly tend to preserve the leather from external atmospheric influences. It is, however, a debatable question whether the glaire does not interfere with the pliability of the leather at the joints, and at the portion of the leather which bends when the book is opened. This also applies to the use of resinous varnishes as preservatives, and if used at all, such finishes should be applied so as not to penetrate below the surface.

We have examined samples of the pastes which are used by bookbinders, and have not found anything which would be likely to be detrimental to

* A small percentage of sulphuric acid, quite sufficient to be ruinous to leather, was until recently a legalised addition to ordinary vinegar. Distilled vinegar, or much-diluted acetic acid, is to be preferred. It should give no precipitate with a solution of barium chloride.

the skins; but it is important that the paste should be used in a fresh condition, otherwise it is liable to undergo an acid fermentation, and to favour the growth of injurious moulds and bacteria. Camphor, and many essential oils, or very small quantities, not exceeding 1 per thousand, of mercuric chloride (corrosive sublimate) are effective antiseptics for paste.

The stretching of leather tightly over books in a wet condition has the same bad effects as drying skins nailed on boards, but in an almost greater degree, and it should be strongly condemned.

5.—*PRESERVATION OF BOOKS.*

Much light has been thrown on the influence of various outside conditions existing in libraries on the durability of leather, by a series of very careful experiments made by the Committee. These experiments prove conclusively that the acid fumes of burnt gas (owing to the sulphuric acid which they contain) are the most fatal of all the influences to which bindings are ordinarily exposed, producing what has been described as "red decay" on every sort of leather to which they have had access, the effect being most marked on the East India tannages, and other leathers made with tannins of the catechol class; and least so upon those with sumach, and other tannins, such as myrobalanes, which are known to be pyrogallol derivatives, while oak-bark occupies an intermediate position, both practically and chemically. It was shown that thirty days' exposure to the fumes of a very small gas jet

rendered East India leather (tanned with turwar-bark) perfectly rotten, so that the surface could be scraped off with the finger-nail, while on leather tanned with sumach it had comparatively little effect. Similar experiments were made with exposure to sunlight during thirty days in the summer, and in this case, again, the leathers were affected in the same order; turwar, quebracho, larch-bark, and gambier being among the worst, and sumach and myrobalanes the least affected; while oak-bark, as before, occupied an intermediate place, being somewhat darkened but comparatively little tendered. It was found that serious effects, very similar to those of light, were produced by exposure during thirty days to air at a temperature not exceeding 110° to 120° F., dry air being apparently slightly the more deleterious.

Experiments made by exposure to artificial light from both ordinary and incandescent gas burners and from incandescent electric lamps during thirty days show marked darkening, but it may be questioned whether the effects observed were not partially due to the radiant heat. Attempts made to decide whether the darkening effects observed were due to oxidation, by exposing samples to oxygen, air, and carbon di-oxide, and in a good but not perfect vacuum, proved inconclusive, light, warmth, and moisture having apparently more influence than oxygen.

Some attempts have been made to determine the effect of light transmitted through glasses of different colours, and they point to the fact that blue and violet glass pass light of nearly as deleterious quality as white glass; while leathers under red,

green, and yellow glasses were almost completely protected. These statements are true not only of East Indian tanned skins but of those tanned with sumach, though the latter were much less affected, even by the blue, white, and violet light, again demonstrating the greater power of resistance of sumach tannage. There can be no doubt that the use of pale yellow or olive-green glass in library windows exposed to direct sunlight is desirable. A large number of experiments have been made on tinted glasses, with the result that dark yellows and oranges give almost complete protection from the effects of sunlight, while even very pale yellows and olives tend greatly to reduce its destructive effect. The glasses employed were subjected to careful spectroscopic examination, and to colour-measurement by the tintometer, but neither were found to give precise indications as to the protective power of the glasses, which is no doubt due to the absorption of the violet, and especially of the invisible ultra-violet rays. An easy method of comparing glasses is to expose under them to sunlight the ordinary sensitised photographic paper. Those glasses under which this is least darkened are also most protective to leather, showing that, as with silver chloride, it is chiefly the so-called "actinic," or ultra-violet rays, which produce the chemical action.

The effects of ammonia vapour and tobacco fumes, of which ammonia is one of the active ingredients, were also examined. The effect of ammonia fumes was very marked, darkening every description of leather, and it is known that in extreme cases it causes a rapid form of decay. Tobacco smoke had a very similar darkening and deleterious effect (least

marked in the case of sumach-tanned leathers), and there can be no doubt that the great deterioration of bindings in a library where smoking was permitted and the rooms much used, must have been partly due to this cause.

Tests were made with the Niger red goat-skin now so largely used for high-class bookbinding, by exposure to light, air, gas fumes, and dry heat. By none of them does it seem to be much affected, and the opinion of the bookbinders is confirmed, that it is one of the most durable tannages. The skin is probably tanned with gall-nuts, or some closely allied material. The nature of the dye has not been definitely ascertained.

Enquiries have frequently been made as to the use of preservative pastes upon old bindings. It has been mentioned (p. 66) that the seasonings of white of egg or blood albumen usually employed in finishing leather have some preservative effect, and no harm can arise from the application of very thin coatings of white of egg. The use of ammonia to thin or preserve the solution must be avoided, but the whites, after thorough beating, may be rendered antiseptic by the addition of a small quantity of camphor, thymol, or some essential oil. Vaseline has been employed as a dressing, and, if otherwise suitable, will no doubt have a preservative effect upon the leather. A very moderate use of the wax, soap, and turpentine preparations made as shoe pastes, is also likely to be beneficial, and no doubt a special preparation might be made on these lines which would be still more suitable. Paraffin wax dissolved in benzine is also harmless, and the surface to which it has been applied takes a good

polish with a flannel after drying. Prof. Procter has experimented with a finish introduced by the Berlin Aniline Company some years ago for coloured leathers, with apparently very satisfactory results. The preparation is practically a very hard stearine soap with excess of stearic acid, and is made by boiling 8 parts of stearic acid with 1 part of caustic soda and 50 parts of water until thoroughly dissolved, and then adding 150 parts of cold water and stirring till the material sets to a jelly. It is applied very thinly with a sponge or rag, and after thorough drying is polished with a soft brush or flannel. The alkali present in the soap is useful in neutralising any mineral acids contained in the leather. In very acid leathers it has been noticed that the sodium sulphate so formed will sometimes appear upon the surface as a white film, but this is easily removed with a damp cloth, and the surface, after drying, repolished with flannel.

APPENDIX I.

HINTS TO OWNERS AND KEEPERS OF LIBRARIES.

BY THE CHAIRMAN OF THE COMMITTEE.

THE following suggestions may, perhaps, be found useful, especially to the owners of private libraries. There is no novelty in them, but the rules inculcated are too commonly neglected, and much injury to books is thereby caused.

1. Rooms in which books are kept should not be subject to extremes, whether of heat or cold, of moisture or dryness. It may be said that the better adapted a room is for human occupation, the better it is for the books it contains. Damp is, of course, most mischievous, but over-dryness, induced by heated air, especially when the pipes are in close proximity to the book-cases, is also very injurious. The bad effect of the fumes of burnt gas and tobacco has been dwelt upon in the Report. Good ventilation is a palliative of these evils; glass cases, also, as has been pointed out, are a valuable protection to books, but they are expensive, and books stored in them lose much of their decorative effect, and are not very accessible.

2. Dust should not be allowed to accumulate on books or in book-cases, for hygienic reasons. But dust, especially in conjunction with damp, is injurious also to books, and should be frequently removed. Besides this indispensable precaution, books should be taken down from the shelves at least once a year, opened, and left for some hours before being replaced. The mischief done in private libraries by careless housemaids employed on this work as a part of the "spring cleaning" is incalculable. The books are ruthlessly pulled out by the top edges of their backs, violently slammed to expel the dust, frequently dropped, and invariably misplaced on their return to the shelves. In small and valuable libraries the work is best done, and no doubt often is done, by the owner. In large libraries an intelligent and book-respecting man should be specially employed. Dust may to a considerable extent be kept out by leather valances.

3. It is important that a just medium should be observed between the close and loose disposition of books in the shelves. Tight packing of books causes the pulling off of the tops of their backs, injurious friction between their sides, and undue pressure, which tends to force open their joints. But books should not stand loosely on the shelves. They require support and lateral pressure, otherwise the leaves are apt to open and admit dust, damp and mildew. The weight of the leaves also in heavy volumes loosely placed will often be found to be resting on the shelf, making the backs concave, and spoiling the shape and cohesion of the books.

In libraries where classification is attempted there must be a certain number of partially filled

shelves. The books in these should be kept in place by some device as that in use in the British Museum, namely, a simple flat angle piece of galvanised iron, on the lower flange of which the end books rest, the upright flange keeping the books close, and preventing them from falling.

4. Great care should be exercised when bookcases are painted or varnished that the surface should be left hard, smooth, and dry. Bindings, especially those of delicate texture, may be irreparably rubbed if brought into contact with rough or coarsely painted surfaces, while the paint itself, years after its original application, is liable to come off upon the books, leaving indelible marks. In such cases pasteboard guards against the ends of the shelves are the only remedy.

5. Persons who care for the appearance of their books should take particular note of the condition of their backs and joints. When the joints begin to crack, early treatment is the cheapest and the most efficacious. The main object of all such repairs should be the conservation of the back, as far as possible, in its original state. If it is sound, nothing but skilful patching or re-jointing is needed. But when a back has become structurally unsound, or the surface leather shows signs of decay, it is too commonly the practice to sacrifice the old back and entirely re-back the volume, often to the great detriment of its appearance and value. This, of course, in many cases cannot be avoided, but it is often quite possible to remove the surface leather, re-back the book, and paste on again the old leather, which, unless it is too far gone, will last many years. Even if the old back has to be entirely replaced,

much of its character may be retained by saving and repasting the old letter pieces.

6. Books, especially those in old calf bindings, in many ways benefit greatly by the application to them of some polish. The surface of the leather so treated takes a fine polish very pleasing to the eye and touch; friction is greatly diminished, and the books, even if closely packed, can be taken out with comparative ease. The main object of the treatment should, however, be the preservation of the leather, and there is reason to believe that with some preparations this is not effected, and that the leather is made dry and brittle. Until some dressing has been proved to be free from such drawbacks, it is the safest course not to try experiments on valuable books. The best morocco leather indeed seems hardly to require any treatment of the kind described.

APPENDIX II.

THE FADING OF COLOUR FROM SUMACH-TANNED LEATHER DYED WITH COAL-TAR COLOURS.

By M. Chas. Lamb.

IN order to determine the relative permanence of the various coal-tar colours as regards light, about 1500 pieces of sumach-tanned leather were dyed, each with its special dye-stuff, as supplied by the principal German, Swiss, French, and English manufacturers, and were arranged on boards placed horizontally and exposed to light in a glass-house situated in the Botanical Society's Gardens in Regent's Park, London, kindly lent for the purpose by the Royal Botanic Society; half of each pattern being carefully protected from the light, whilst the other halves of the pieces were fully exposed to it. To obtain a standard by which to judge the fading of the colours, six much larger pieces of leather were dyed in colours, say, A, B, C, D, E, and F, known to be not very fast to light, and six sample pieces cut from these, one from each, were exposed along with the 1500. At the end of nine days of bright sunlight, it was found that the colour of the sample cut, say, from D piece, had just faded.

The pieces of dyed leather were then examined, and all those noted that had faded in this first "period."

A second sample from the D piece was now exposed; the period of its fading being, let us suppose, a month, the conditions of weather not being so favourable for bright sunlight. Again, note was made of the colours among the pieces that had faded up to the end of this time, which was counted as a second period. In all, before the investigation came to a conclusion, ten such periods of equal sunshine value to the original nine days, but extending in all over thirteen months, were completed. At the end of that time all the colours had faded.

Along with the dyed pieces of the leather, undyed samples from the same skins were also exposed, that the effect of light upon the colour of the leather, as tanned only, might be ascertained. At the end of the full interval of thirteen months, the colour had perceptibly darkened. In judging of the fading of the dyed pieces allowance was made for this darkening.

In dyeing the leather with the acid colours, sulphuric acid was added to the dye-bath. For dyeing with the basic colours, the excess of tannic acid in the leather was fixed in an insoluble form by treatment of the leather previous to dyeing with a bath of tartar emetic and common salt.

Upon completion of the above investigation further patterns were dyed with acid colours, using formic acid as an addition to the dye-bath, as a substitute for sulphuric acid (the latter being injurious to the leather, see page 47). It was found

that the fading went on in exactly the same manner as when the sulphuric acid was used.*

Leather dyed with mixtures of the various coal-tar colours was also exposed to light (Society of Chemical Industry Journal, November 1903). In every case it was noted that the fading proceeded at the same rate as when the single colouring matter was employed; that is to say, when a shade produced by a mixture of a fugitive and a fast colour was exposed, the fugitive colour faded, leaving the fast colour unaffected.

Formaldehyde was tried as an addition to the dye-bath when dyeing with basic colours; but the addition did not have any effect upon the rate of fading.

The following are the lists of colours which faded in the various "periods," those lasting to the tenth period being, of course, the most permanent.

PERIOD I.

After exposure to light from July 14th to July 23rd (number of days inclusive = 9), the colour had entirely faded from the leather.

Curcumein S.
Eosine O O.
Eosine Y S.
Eosine B S.
Eosine A.
Erythrosine.
Methyl Eosine.
Phloxine B T.
Phloxine N.

* In experiments made at the Leeds University, it was found that samples dyed with formic acid were in many cases less altered by sunlight than those with sulphuric, which frequently became blacker and duller.

PERIOD II.

After exposure to light from July 4th to August 14th (number of days inclusive = 31), the colour had entirely faded from the leather.

Acid Violet 6 B.
Acid Violet R S.
Acid Violet 2 B.
Brilliant Green.
Benzo Flavine.
China Green.
Chrysoidine R E.
Chrysoidine A G.
Chrysoidine O.
Chrysoidine J.
Citronine A.
Emerald Green.
Fast Acid Green B N.
Fast Green Ext.
Imperial Green G 1.
Imperial Green G 2.
Imperial Green G 3.
Malachite Green.
Naphthol Yellow S.
Methyl Violet 2.
Orange 4.
Rose Bengal.
Russian Green B B.
Rheonine N.
Russian Green G.
Russian Green Y.
Russian Red G.
Russian Red 2 C.
Russian Red R.
Solid Green B.
Solid Green Cryst.
Solid Green Cryst. O.
Turquoise Blue B B.
Turquoise Blue G.
Titan Brown R.
Ultramarine Blue.
Vesuvine.
Vesuvine B.

PERIOD III.

After exposure to light from July 14th to September 21st (number of days inclusive = 69), the colour had entirely faded from the leather.

Alkali Blue 6 R.
Alkali Blue 6 B.
Acid Green 3 B.
Acid Yellow.

Period III.—continued.

Auramine 2.
Auramine O.
Auramine G.
Acridine Scarlet 3 R.
Acridine Scarlet R.
Archil Substitute N.
Bismarck Brown G G.
Bismarck Brown N Y Y.
Bismarck Brown F.
Bismarck Brown M.
Bismarck Brown P S.
Bismarck Brown F W.
Bismarck Brown R.
Bismarck Brown O.
Bordeaux B.
Chrysoidine G.
Chrysoidine R.
Chrysoidine Y.
Chrysoidine Y Y.
Chrysoidine Cryst.
Crumpsall Yellow F R P.
Crumpsall Yellow Y Y P.
Cotton Blue R.
Corvoline G.
Cerise A.
Cannella P W.
Cannella L.
Cannella O F.
Cannella N W.
Cannella Y.
Cannella P.
Diamond Blue 3 R.
Diamond Green B.
Ethyl Green.
Eboli Green G.
Fast Acid Blue B.
Fast Acid Violet 4 B.
Formyl Violet S 4 B.
Fast Acid Magenta B.
Lavilliere 2.
Lavilliere 1.
Lazuline Blue R.
Light Green N.
Methyl Green.
Naphthol Yellow.
Neptune Green S.
Phosphine 3 R B.
Phosphine B Ext.
Phosphine 3.
Phosphine 2.
Phosphine 1.
Phosphine N.
Phosphine 3 R.
Phosphine N A.
Phosphine G A.
Philadelphia Yellow G.
Philadelphia Yellow O R.
Philadelphia Brown.
Turmeric Yellow.
Thioflavine T.
Vesuvine Conc.

PERIOD IV.

After exposure to light from July 14th to November 15th (number of days inclusive = 124), the colour had entirely faded from the leather.

Aniline Yellow 2.
Acid Brown R.
Acid Brown B.
Acridine Red B.
Acridine Red 3 B.
Acridine Red 2 B.
Acid Violet 3 B N.
Acid Violet B N.
Acid Violet F S.
Acid Green Ext.
Acid Green B B Ext.
Acid Green G G Ext.
Acid Green 225.
Acid Green O.
Acid Green Conc.
Acid Green Blue Shade.
Azo Acid Violet R Ext.
Azo Acid Violet B.
Atlas Scarlet 1.
Azo Cochineal.
Bordeaux Extra.
Bordeaux Y.
Bismarck Brown Y.
Bismarck Brown Y Ext.
Bismarck Brown R Ext.
Bismarck Brown 2 B.
Bismarck Brown Y S.
Chrysoidine Ext.
Cuba Yellow.
Corvoline B.
Chrysophenine G.
Cyanole Ext.
Cerise D 2.
Cerise N.
Cresyl Fast Blue 2 B.
Cardinal 4 B.
Crimson N.
Carnation M.
Dahlia.
Diamond Magenta.
Eboli Green B.
Fast Brown 3 B.
Fast Navy Blue B M.
Fast Navy Blue A.
Golden Yellow.
Guinea Green B.
Guinea Green G.
Grenadine G.
Indian Yellow T.
Indian Yellow G.
Indigo Blue L.
Indigo Blue N.
Magenta W B.
Magenta R F.
Magenta W B G.
Methyl Blue.
Methyl Green Y S.
Methyl Violet 4 R.
Methyl Violet C.
Methyl Violet 6 B.

PERIOD IV.—continued.

Methyl Violet 3 R.
Methyl Violet R.
Methyl Violet 3 B.
Methyl Violet B Ext.
Methyl Violet 2 B.
Methyl Violet B B.
Methyl Violet B O.
Maroon.
Magenta Scarlet B.
Magenta Scarlet G.
Marine Blue.
New Golden Brown A 1.
New Patent Blue G A.
Naphthol Blue G.
New Victoria Black G.
New Blue B.
Neutral Violet.
New Magenta O.
New Metamine Blue.
Naphthylamine Black R.
Nanking.
Naphthol Blue Black N.
Orange G G.
Phosphine E.
Phosphine L.
Phosphine G.
Phosphine R.
Phosphine W A.
Phosphine 2 A.
Patent Phosphine G G.
Pure Blue Cryst.
Philadelphia Black B.
Pyronine G.
Russian Red R.
Russian Red G G.
Russian Red B.
Russian Red G R.
Resorcin Yellow.
Rosaniline Cryst.
Rubin.
Scarlet G.
Scarlet R.
Solid Green C E.
Solid Yellow B.
Soluble Blue G S.
Soluble Blue R.
Soluble Blue B.
Violet Cryst. O.
Xanthine 3 G O.

PERIOD V.

After exposure to light from July 14th to January 20th (number of days inclusive = 190), the colour had entirely faded from the leather.

Acid Brown L.
Azo Flavine 7032.
Azo Yellow 3 R.
Azo Yellow R.

PERIOD V.—continued.

Azo Acid Brown.
Acid Phosphine J O.
Azo Phosphine.
Auramine Conc.
Acridine Orange N O.
Anthracene Acid Brown G.
Acid Maroon.
Acid Brown R R.
Acid Brown D.
Acid Brown Y.
Acid Green 4 B.
Azo Rubine S.
Azo Fuchsine G W Ext.
Acid Violet R.
Azo Crimson L.
Atlas Orange Y S.
Atlas Orange R S.
Atlas Scarlet 3.
Amaranth.
Bronze Acid Brown.
Bismarck Acid Brown.
Brill. Scarlet 4 R B.
Brill. Scarlet Y Y.
Brill. Scarlet Y.
Brill. Scarlet B.
Carmosine Orange A.
Capri Green 2 G.
Capri Blue G O.
Cardinal 1.
Cardinal 3 B.
Croceine Scarlet B.
Croceine Scarlet R.
Cotton Blue O O.
Double Ponceau 2 R.
Double Ponceau 4 R.
Eclipse Blue.
Erioglaucine.
Fast Blue E 1.
Fast Blue O.
Fast Brown G.
Fast Brown N.
Fast Navy Blue R M.
Fast Red A.
Fast Red Ext.
Fast Red P R Ext.
Fast Violet B S.
Fram Blue G.
Golden Brown Y.
Golden Orange.
Homophosphine G.
Induline B.
Mandarine Q Ext.
Methyl Blue.
New Phosphine.
Naphthylamine Brown.
Naphthol Brown.
Nigrosine W.
Nigrosine G O.
Nigrosine R.
Naphthylamine Black 4 B.
Naphthylamine Black 6 B.
New Blue R.
Orange S.

PERIOD V.—continued.

Orange 2.
Orange 2 B.
Orange P.
Orange G.
Orange G. T.
Orange N.
Orange Ext.
Orange Ext Conc.
Orange A.
Pure Blue P.
Patent Phosphine 3 R.
Ponceau 4 G B.
Ponceau 3 R Ext.
Ponceau 2 R.
Ponceau Y.
Phosphine Yellow R.
Rhodamine 6 G N.
Scarlet B.
Scarlet Y.
Safranine G Ext.
Scarlet 3 R.
Scarlet B B.
Scarlet G 1.
Safranine Ext.
Solid Blue G.
Victoria Black G.
Water Blue 3 B.

PERIOD VI.

After exposure to light from July 14th to April 12th (number of days inclusive = 272), the colour had entirely faded from the leather.

Azo Bordeaux.
Acid Violet 3 B A.
Azo Fuchsin B.
Acid Green 5677.
Atlas Scarlet 6.
Bordeaux 3 B.
Burmese Red.
Brill. Croceine M O O.
Curcumein Extra.
Croceine Scarlet B.
Croceine Scarlet 6 R.
Cochineal Scarlet P S.
Dark Nut Brown.
Fast Red K G.
Induline A.
Induline L.
Methylene Blue B.
Milling Red R.
Nigrosine L T.
Nigrosine J B.
New Phosphine Pure
New Patent Blue 4 B.
New Claret L.
Ponceau 10 R B.

PERIOD VI.—continued.

Ponceau 4 R.
Ponceau B O.
Ponceau 4 R B.
Ponceau 6 R B.
Safranine A G Ext.
Safranine 2.
Scarlet 4 R.
Solid Brown O.
Sloeline B S.
Victoria Black.
Wool Ponceau L R.

PERIOD VII.

After exposure to light from July 14th to May 4th (number of days inclusive = 294), the colour had entirely faded from the leather.

Azo Yellow P S.
Azo Flavine.
Acid Magenta O.
Azo Bordeaux.
Archil Red A.
Azo Crimson S.
Bordeaux B Ext.
Bordeaux B L.
Brill. Croceine 3 B.
Croceine Scarlet 8 B.
Croceine Scarlet 7 B.
Claret Red B.
Cotton Blue 2.
Cuba Yellow.
Croceine A Z.
Fast Milling Red B.
Flavinduline 2.
Fast Scarlet B.
Induline N W.
Indian Yellow R.
Methylene Blue B B.
Methylene Red G.
Methylene Blue 2 R.
Orseillien.
Phenol Black S S.
Phosphine Substitute.
Quinoline Yellow.
Turmeric Substitute.
Tartrazine.
Solid Yellow G.
Resorcin Brown.
Rhodamine B.
Solid Blue R.
Safranine 1 Extra.
Safranine T.
Safranine Scarlet B.
Scarlet E C.
Victoria Black B.
Water Blue R.
Water Blue 3 R.
Water Blue B T R.
Water Blue P P.
Water Blue B B.

PERIOD VIII.

After exposure to light from July 14th to June 1st (number of days inclusive = 322), the colour had entirely faded from the leather.

Azo Fuchsine S.
Azo Acid Magenta B.
Acid Green V.
Bavarian Blue D B.
Bordeaux S.
Brill. Safranine G.
Brill. Safranine O.
Brill. Rhoduline Red.
Chromotrope 6 B.
Cotton Blue B B.
Cotton Blue L.
Cresyl Blue 2 B S.
Chromotrope 2 R.
Fast Blue R.
Fast Red S.
Induline R.
Imperial Scarlet.
New Methylene Blue N.
New Methylene Blue G G.
New Methylene Blue B B.
Nigrosine B.
Ponceau O R B.
Rhodamine B Extra.
Swiss Blue R.
Scarlet B Extra.
Victoria Black Blue.
Violamine R.
Water Blue 4 B.

PERIODS IX. and X.

After exposure to light from July 14th to August 15th (number of days inclusive = 397), the colour had entirely faded from the leather.

Violamine.
Nigrosine W G.
Fast Blue 5 B.
Acid Violet 4 R.

[Some illustrations of the effect of light on dyed leathers are given in Plates X. and XI.]

APPENDIX III.

CIRCULAR TO LIBRARIANS, AND REPLIES.

THE following circular letter was sent to Librarians :—

September 1900.

DEAR SIR,

In consequence of the widespread feeling of dissatisfaction among those interested in the care of books respecting the perishable nature of certain leather used for bookbinding, the Council of the Society of Arts were moved to institute an investigation into the character of the evil, and the best means of remedying it. An influential Committee has been appointed to consider the whole question and report to the Council.

Two Sub-Committees are also at work. One has undertaken to visit libraries, and to collect evidence as to the perishing of modern leather as compared with that formerly used; and another Committee has undertaken to report on the manufacture of leather, to investigate the causes of its decay, and, if possible, to suggest remedies.

The Committee, recognising the importance to

Librarians of the preservation of books committed to their care, have drawn up a few questions for submission to those specially interested in the subject, and they hope you will give them the benefit of your opinions on the annexed form.

They will also feel much obliged if you will favour them with any further information which you think may assist the Committee, or with any suggestions which your experience may lead you to make.

Yours faithfully,

HENRY TRUEMAN WOOD,
Secretary.

Thirty-nine replies have been received to the following questions:—

I.—(*a*) Do any of your leather bookbindings show marked deterioration; and, if so, (*b*) What is, in your opinion, the cause?

(*a*) Thirty-one replied yes; two replied no; four were undecided; (*b*) twenty-one, gas; six, bad leather.

II.—What class of leather do you consider the best for bookbinding?

Morocco and pigskin recommended by almost all; cloth by six; calf by three; Russia by one; vellum by three; bark-tanned leather by one; sealskin by one (a member of the Committee); Persian recommended by one and condemned by one.

III.—What are the conditions of your library as to lighting, heating, and ventilation?

Twenty-eight now use electric light where gas was formerly used; hot water and open fires generally used; ventilation good in twenty cases.

IV.—Have any regular means been taken to prevent your leather bindings from decaying, by the use of some preservative application?

Twenty-five have not used regular means; four used vaseline; two used cuirine; one (a member of the Committee) used furniture polish.

If you can assist the Committee by giving any further information, or by sending any small samples of decayed leather (with approximate date of binding) it will be esteemed a favour.

LIST OF LIBRARIES SENDING ANSWERS TO THE ABOVE QUESTIONS.

Arbroath—Public Library.
Aston Manor—Public Library.
Birmingham—Central Free Library.
,, (Margaret-street)—Library.
Bolton—Public Library.
Bradford—Public Free Library.
Blackburn—Free Library.
Brighton—Public Library.
Bristol—City Library.
,, Museum Reference Library.

Cambridge—Trinity College Library.
„ Free Library.
Dublin—National Library of Ireland.
„ Trinity College Library.
Glasgow—The Mitchell Library.
Liverpool—Public Library.
London—British Museum Library.
„ (South Kensington)—Board of Education Library.
„ (South Kensington)—National Art Library.
„ India Office Library.
„ Incorporated Law Society Library.
„ Museum of Practical Geology Library.
„ Patent Office Library.
„ Royal College of Surgeons' Library.
„ Royal Geographical Society's Library.
„ Royal Statistical Society's Library.
„ Royal Society's Library.
„ Society of Antiquaries' Library.
„ University College Library.
Manchester—Athenæum Library.
„ Christie Library, Owens College.
Nottingham—Public Library.
Oxford—Christ Church Library.
„ Magdalen College Library.
Penzance—Public Library.
West Bromwich—Free Library.
Wigan—Public Library.
Wolverhampton—Free Library.
Worcester—Corporation Library.

The two libraries reporting no serious decay of leather use no artificial light, and report the ventilation as being good.

	Question I.		
	Yes.	No.	Cause.
Arbroath, Public Library	—	—	—
Aston Manor, Public Library*	Yes		Gas
Athenæum, Manchester	Yes		Gas
Birmingham, Central Free Library	Yes (not to any serious extent)		Gas (want of ventilation in one room)
„ Margaret Street Library	Yes		Gas
Blackburn, Free Library	Yes		Bad ventilation
Bolton, Public Library	Yes		Gas (fumes from iron forge)
Bradford, Public Library	Yes		Gas, heat
Brighton, Public Library	Yes		Gas
Bristol, City Library	Yes		Gas
„ Museum Reference Library	Yes		Gas (bad ventilation)
British Museum	Yes		Acid
Cambridge, Free Library	Yes		Quality of leather
„ Trinity College Library		No	—
Dublin, National Libraries of Ireland (formerly) ..	Yes (not since e. l. installed)		Gas
„ Trinity College	Yes		—
Glasgow, Mitchell Library	Yes		Gas (Persian Morocco bad)
Incorporated Law Society	Yes		Bad calf
India Office	Yes		Heat, cold
Kensington (South), Board of Education	—		Russia bad
Liverpool, Public Library†	Yes		Gas, heat
Museum of Practical Geology	Yes		Gas (calf bad)
Nottingham, Public Library (calf and Russian, worst)	Yes		Bad leather
Owens College	Yes		Gas
Oxford, Christ Church Library	Yes		Gas (age, damp, heat)
„ Magdalen College		No	—
Patent Office	Yes		Bad leather
Penzance, Public Library	Yes		Bad leather
Royal College of Surgeons	Yes (before e. l. installed)		—
Royal Geographical Society	Yes		Gas, smoke
Royal Society	Yes		Various, London air, dryness
Royal Statistical Society	(No falling off in quality noticed)		
University College, London	Yes		Gas
West Bromwich, Free Library	Yes (all on high shelves)		Gas
Wigan, Public Library	Yes		Gas (chemicals in tannery)
Wolverhampton, Free Library	Yes		Gas
Worcester, Corporation Library	Yes		Gas, bad leather

* Leather of reddish brown or orange colour

† Liverpool reported that leather bindings on books circulated from lending department

Question II.	Question III.			Question IV.
	Light.	Heat.	Ventilation.	
—	Electric	Hot water	—	No
Morocco and pigskin for books in use; cloths for books not used	Electric	Hot water	Tobin	Vaseline
Pigskin and pegamoid	Electric	Hot water	Good	No
Morocco and pigskin (natural colour)	Electric	Hot water	Good	No
Morocco and vellum	Electric	Hot water	Good	No
Pigskin	Electric	Hot water	Electric fans	Vaseline (slightly beneficial)
Morocco, pigskin, buckram	Electric	—	Not over good	No
Pigskin	Electric	Hot water	Boyles'	No
Morocco	Electric	Hot water	Imperfect	Vaseline
Morocco and pigskin	Gas and e. l.	Hot water	Tobin	Glercine or varnish
Morocco	Electric	Hot water	In roof	No
Bark tanned leather	Electric	Hot water	—	—
Morocco and pigskin	No	Good	Good	No
Morocco and pigskin	No artificial	Hot water	Good	Vaseline
Morocco	Electric	Hot water	Good	No
Morocco	No artificial	—	Good	No
Morocco and pigskin	Electric	Hot water	Good	No
Russia, coloured calf	Electric	Open fires	Good	No
Morocco	Electric	Hot water	—	No
Morocco	Electric	Hot water	Draughty	No
Cloth and Morocco	Electric	Hot water	Good	Yes, but no good result
Morocco	Electric	Hot water	Good	Yes
Dark Morocco	Electric	Hot water	Window	Cuirine
Morocco	Electric	Hot water	—	No
Morocco and pigskin	Gas	Open fires	—	Yes, furniture cream
—	No artificial	—	Good	No
Light calf	No	Excellent	—	No
Pigskin and Morocco	Gas	Hot water	Good	No
Morocco and cloth	—	Open fires	—	—
Cloth	Electric	Open fires	—	No
Morocco	Electric	Hot water	—	No
Calf, cloth and buckram	Gas	Gas	No special	Not now
Velvet, pigskin, Morocco	Electric	Steam pipes	Good	—
Pigskin only	Gas	Hot water	Good	Yes
Morocco and velvet	Gas	—	—	Yes, not satisfactory
Persian and pigskin	Electric	Hot water	Bad	No
Morocco and calf	Electric	Hot water	Gas	No

the worst. Cloth better for books not used.

do not suffer in the least from decay as is the case with so many in reference libraries.

PLATES II.–XI.

PLATE No. II.—SUMACH PERSIAN SHEEP.

Lower halves exposed for 30 days to—

(1) Light and air.

(2) Light and air, and gas fumes.

(3) Dry air alone, 110° to 120° Fahr.

(4) Dry air, 110° to 120° Fahr., and moist air alternately.

(5) Dry air and moist air, and gas fumes in succession.

PLATE II.

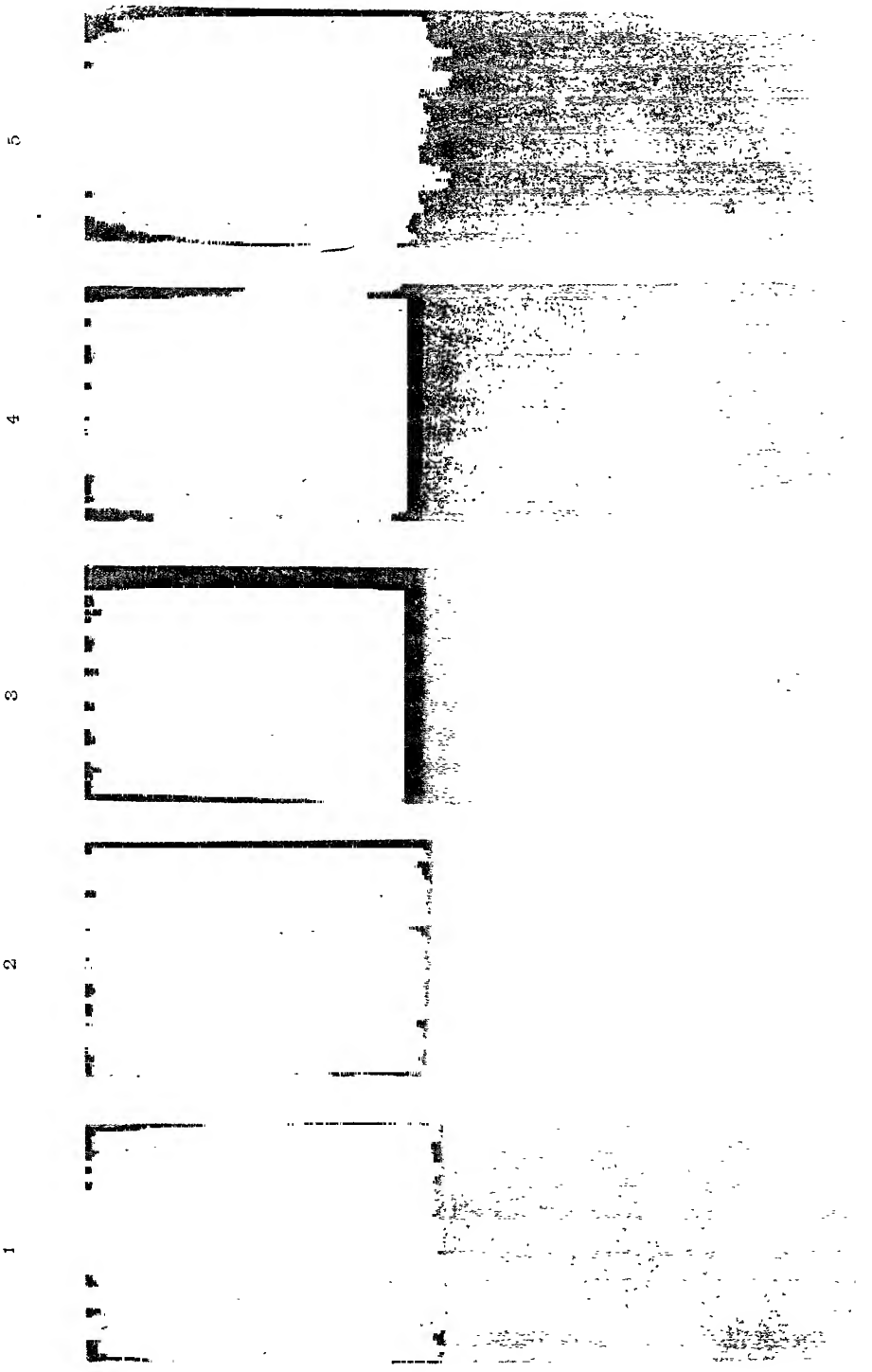


PLATE No. III.—SUMACH CALF.

Lower halves exposed for 30 days to—

(1) Light and air.

(2) Light and air, and gas fumes.

(3) Dry air alone, 110° to 120° Fahr.

(4) Dry air, 110° to 120° Fahr., and moist air alternately.

(5) Dry air and moist air, and gas fumes in succession.

PLATE III

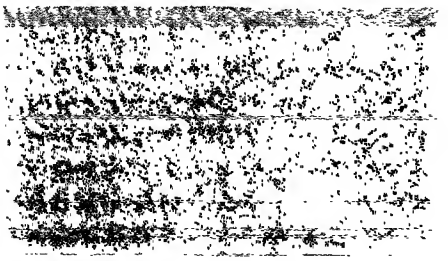


PLATE No. IV.—LIGHTLY DETANNISED PERSIAN SHEEP.

Lower halves exposed for 30 days to—

(1) Light and air.

(2) Light and air, and gas fumes.

(3) Dry air alone, 110° to 120° Fahr.

(4) Dry air, 110° to 120° Fahr., and moist air alternately.

(5) Dry air and moist air, and gas fumes in succession.

PLATE IV

PLATE NO. V.—LEATHER TANNED WITH VARIOUS TANNING MATERIALS.
Upper halves exposed to light for 30 days.

(1) Sumach.

(2) Oak Bark.

(3) Myrabolanes.

(4) Gambier.

(5) Quebracho.

(6) Larch Bark.

PLATE V.

PLATE No. VI.—VARIOUS SAMPLES OF LEATHER exposed to air and the white light of an incandescent gas lamp for 30 days (upper half exposed).

(1) Sumach Calf.

(2) Sumach Skiver.

(3) Detannised East India tanned Sheep.

(4) Sumach East India tanned Sheep.

PLATE VI.

4

3

2

1

PLATE No. VII.—VARIOUS SAMPLES OF LEATHER exposed to air and the light of Bray's No. 5 gas burner for 30 days (upper half exposed).

(1) Calf Sumach tanned.

(2) Skiver Sumach tanned.

(3) Lightly detannised East India tanned Sheep, but not retanned.

PLATE VII.

PLATE No. VIII.—LEATHER EXPOSED UNDER LIGHT OF VARIOUS COLOURS.

No. 1 (Left-hand).—Sumach tanned Skiver.

No. 2 (Right-hand).—East India tanned Sheep.

(A) White light. (B) Green. (C) Blue. (D) Yellow. (E) Red. (F) Violet.

PLATE VIII

1

2

a

b

c

d

e

f

PLATE No. IX.

(1) SUMACH TANNED CALF SKIN, exposed to light under a sharp photographic negative for 30 days.

(2) EAST INDIA TANNED GOAT SKIN, exposed to light for 30 days under a piece of lace.

PLATE IX.

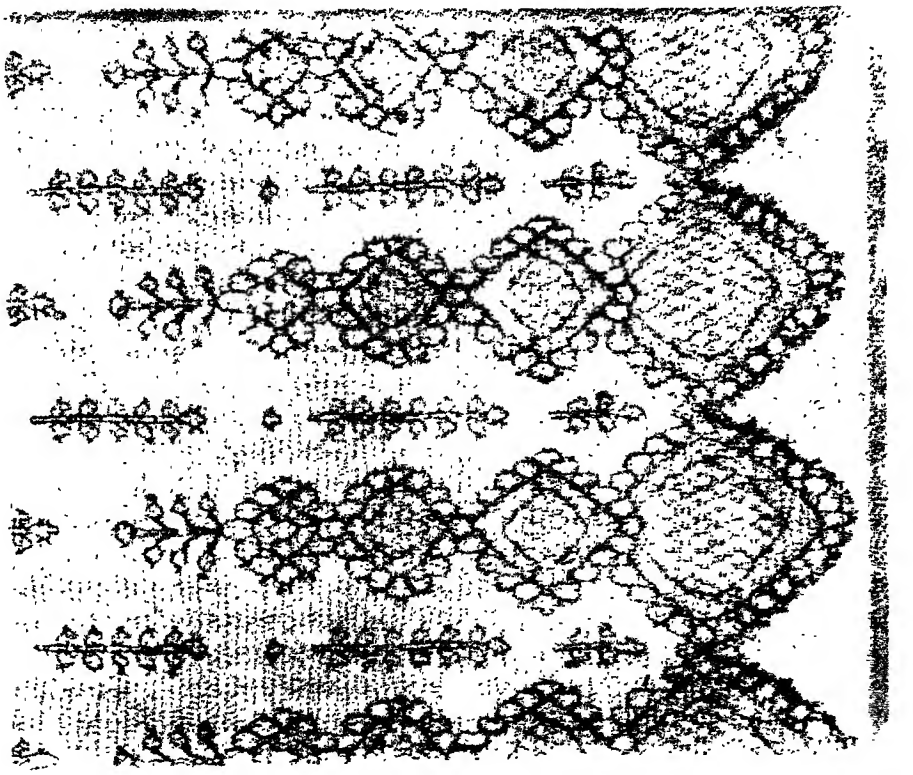


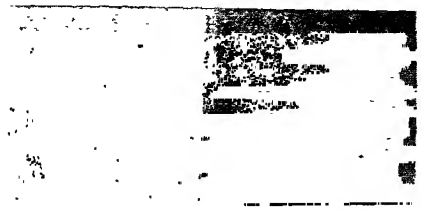
Plate No. X.

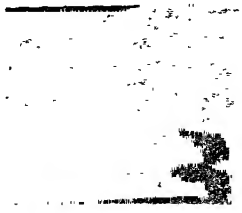
Nos. 1 to 6 show the effect of exposing patterns of Sumach tanned leather, dyed with various "Basic" dyestuffs, to direct sunlight for a period of 60 days.

Nos. 7 to 12 show the effect of exposing patterns of Sumach tanned leather, dyed with various "Acid" dyes, to direct sunlight for a period of 60 days.

Note.—In each case the left-hand half of the pattern was exposed, the right-hand half being protected from the light.

PLATE X.





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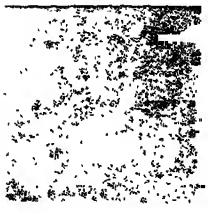

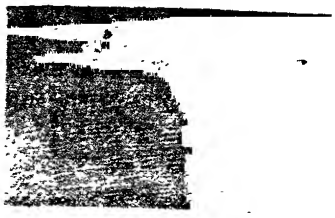

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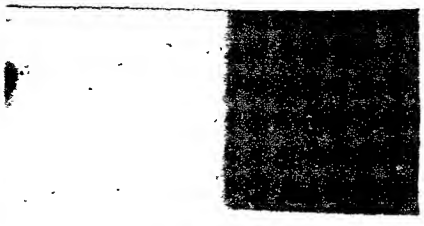

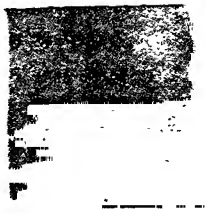

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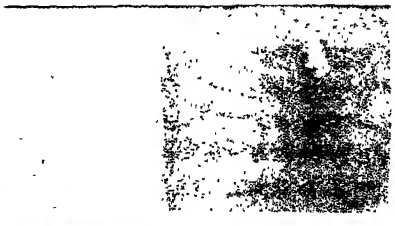

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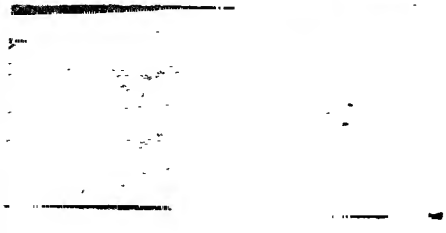

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Plate No. XI.

(1) Pattern of Combination Chrome tanned leather, dyed with fast colour and exposed to light for 300 days.

(2) Pattern of Chrome tanned leather, mordanted with Oakwood extract, previous to dyeing with same dyestuff as used for pattern (1), and exposed for 300 days.

(3) Pattern of Alumed leather, dyed without mordant, using same dyestuff as for pattern (1), and exposed for 30 days.

(4) Pattern of "Single-Bath" Chrome leather, dyed without mordanting, using same dyestuff as for pattern (1), and exposed for 30 days.

(5) Pattern of "Single-Bath" Chrome leather, dyed with a colour which is noted for exceeding fastness upon Sumach tanned leather. Exposed to light for 20 days.

(6) Pattern of "Double-Bath" Chrome leather, dyed with same dyestuff as pattern (5). Exposed to light for 20 days.

(7) Effect of exposing Sumach tanned leather, dyed green with a mixture of a fast yellow and a fugitive blue. The blue fading leaving the yellow behind.

(8) Effect of exposing Sumach tanned leather, dyed green with a mixture of a comparatively fast blue and a more fugitive yellow. The yellow fading more quickly than the blue, thus leaving the leather a pale blue shade.

(9) Dyed with a fast colour. Exposed to light for 12 months.

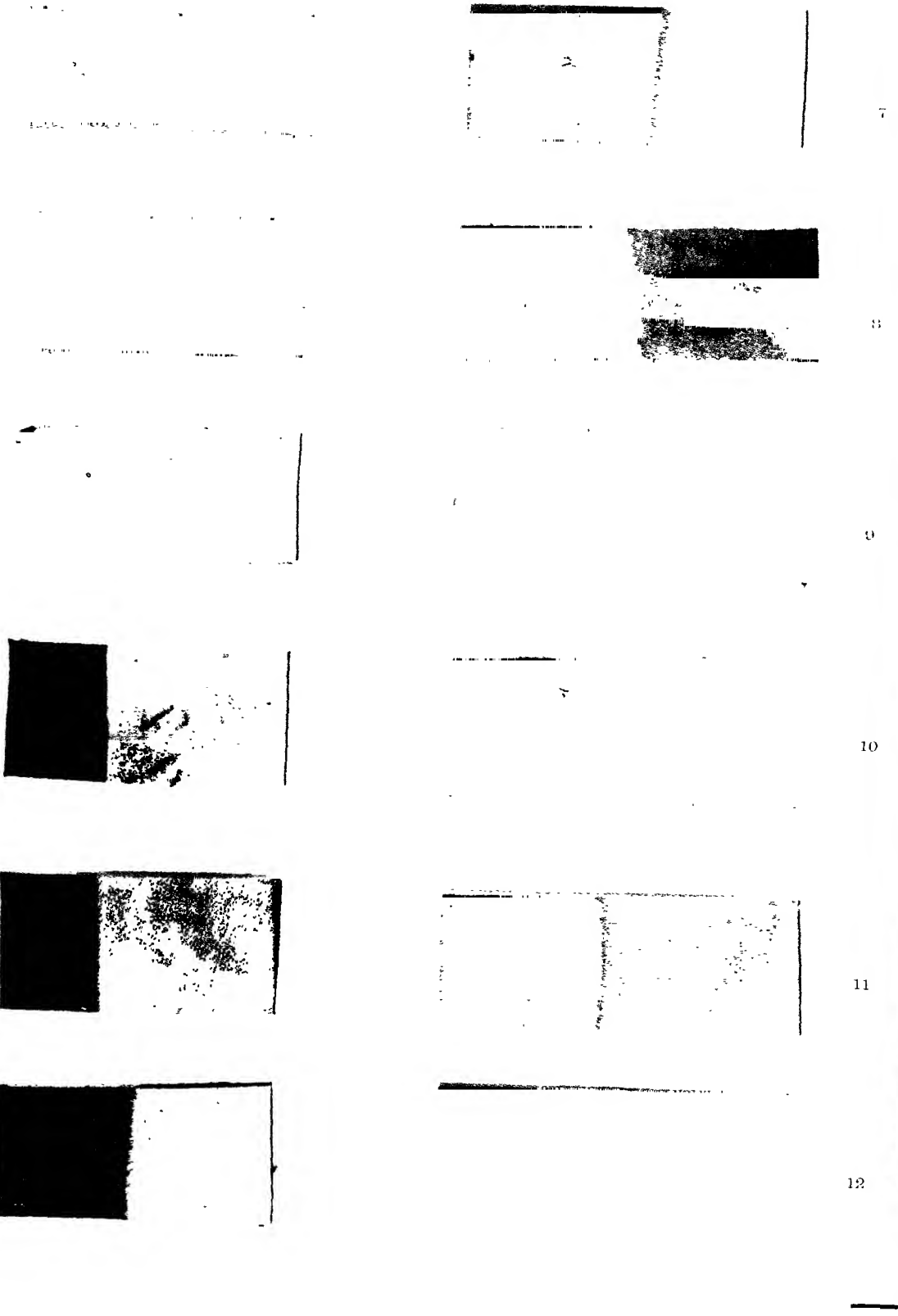
(10) Pattern dyed on "Persian" Sheep, showing effect of light in darkening the leather, and so altering shade of colour.

(11) Pattern of Sumach skiver, dyed with moderately fast "Basic" dye. Exposed to light for 300 days.

(12) Pattern of Sumach tanned leather, dyed with moderately fast aniline black and a more fugitive blue. Effect after exposing 300 days. Blue entirely faded. Black still unaltered.

Note.—In each case the right-hand half of the pattern was exposed, the left-hand half being protected from the light.

PLATE XI.



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LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
GREAT WINDMILL STREET, W., AND DUKE STREET, STAMFORD STREET, S.E.

THE samples of leather in the cover have been prepared in accordance with the conclusions of the Report of the Committee, and were supplied by the following firms: The calf-skin, goat-skin, and sheep-skin by Messrs. J. Meredith-Jones & Sons, Wrexham; the seal-skin by Messrs. Edw. & Jas. Richardson, Newcastle-on-Tyne; and the pig-skin by Messrs. John Muir & Son, Beith, N.B.